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The Institute of Vitreous Enamellers

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and

The Foundry Trades' Equipment and Supplies Association

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The Week-End Conference in Paris

The 28th Annual Conference of the French Foundry Technical Association was held last Saturday under the Presidency of Mr. J. Lobstein at their new headquarters. These eminently suitable premises are shared with the Syndicat des Fondeurs—that is, the Foundry Employers' Federation. It is a French custom that the President actually delegates the job of presiding over such a meeting to some distinguished personality. Thus, for the morning session, the chair was taken by Mr. H. Luc, the Minister for Technical Education, and in the afternoon, Mr. Léonard, of Belgium, was chairman. Even at the official luncheon, it was Mr. Luc who was in the chair. A pretty and practical compliment was paid to the forthcoming International Congress, in London, for the French Association limited their own annual conference to one day with the express intention of emphasising the importance of the international gathering. Despite that, there were some two hundred participants present at the morning and afternoon sessions. At the former, four Papers were read embracing a very diverse range of subjects. First a joint Paper by Prof. Portevin and Mr. Waeles on foundry training was read, and naturally enough in the main was centred around the work of the Paris Foundry School. This was followed by a practical discourse on the collaboration between the foundry and the drawing office, by Mr. André. This Paper, which we intend to translate and publish, is an attempt to rationalise pieces of practical work carried out in all the various countries. Then, in the absence of the author, Mr. Ageron, of Pont-à-Mousson, Mr. Roger Mayer read a Paper on safety-first in the foundry. The chairman, Mr. H. Luc, took a profound personal interest in this Paper, and correlated its findings with improved production methods. The last Paper, by Mr. Vallat, dealt with foundry lighting and its war-time significance. Here we were able to intervene to outline some of the latest British ideas on the subject.

At the luncheon, the guests were treated to oratory by Mr. Olivier (the President of the employers' federation), then by Mr. Lobstein, and finally, by the Minister. The last speaker had the pleasant duty of presenting the Association's medals to Mr. V. Delport, for his great work in the field of international co-operation; to Mr. J. M. Espana, for his contribution towards the production of the international dictionary, and to Mr. J. Challansonnet for his researches on alloyed cast iron.

The afternoon session started somewhat late, and lasted until seven o'clock. The first Paper was supposed to deal with the mechanism of corrosion in cupola refractory linings, but the author, Mr. Y. Letort, has carried out laboratory experiments using materials obtained from the cupola and filling them into cylindrical holes made in a series of refractories. He used slag from the cupola dump, a mixture of limestone and ash from the coke used in this furnace, and a mixture of limestone, coke ash and iron oxide, in association with six types of refractories. It was an intellectual pleasure to listen to the results of these experiments by a man who is obviously a master of his subject, but as the slag would vary with each type of refractory used, the practical application was not very direct. He was followed by Colonel Dupuy, who covered the subject of the radiographic examination of steel castings, much in the same way as Mr. F. W. Rowe will do in a Paper to be presented to the London Congress. Then came a lecture on the evolution of bearing alloys by Mr. Challansonnet, to be followed by Mr. Girardet on pig-iron and high-duty castings. As practically all the eight Papers were read from beginning to end, it illustrates the keenness of the French foundrymen to acquire technical knowledge. There was a minimum of discussion, but again it is a French tradition that the chairman should make a short contribution after each lecturer has presented his Paper, and the choice of chairmen was indeed fortunate. We always receive the impression that conferences are taken more seriously in France than here, for we are reasonably certain that only a handful of participants would undertake to sit through six hours of technical sessions on a fine Saturday afternoon!

We feel that we must return thanks for the heartiness of the welcome and the magnificence of the hospitality which was accorded to us. It was, moreover, pleasing to learn that a large and important French delegation is to participate in the London Congress.

Civil Defence Research

Sir John Anderson, the Lord Privy Seal, has appointed a special Committee to advise on the formulation and execution of further programmes of research and experiment in connection with the problems of Civil Defence. The Committee will also survey programmes already in progress with a view, as in the case of future programmes, to securing the fullest possible co-ordination of the wide field of work which is now being undertaken.

This Committee will be known as the Civil Defence Research Committee. It is composed as follows :—Dr. E. V. Appleton, M.A., D.Sc., LL.D., F.R.S. (formerly Jacksonian Professor of Natural Philosophy, University of Cambridge, now Secretary of the Department of Scientific and Industrial Research); Prof. J. F. Baker, M.A., Sc.D., Assoc.M.Inst.C.E., M.I.Struct.E. (Professor of Civil Engineering, University of Bristol); Prof. J. D. Bernal, M.A., F.R.S. (Professor of Physics, Birkbeck College, University of London); Dr. C. G. Darwin, M.C., M.A., Sc.D., F.R.S., Director, National Physical Laboratory; Prof. A. J. S. Pippard, M.B.E., D.Sc., M.Inst.C.E. (Professor of Civil Engineering in the Imperial College, University of London); Prof. R. V. Southwell, M.A., F.R.S. (Professor of Engineering Science, University of Oxford); Prof. G. I. Taylor, F.R.S. (Yarrow Research Professor of the Royal Society of Cambridge); Prof. W. N. Thomas, M.A., D.Phil., M.Inst.C.E., M.I.Struct.E., M.I.Mech.E. (Professor of Engineering, University College, Cardiff). The Secretary of the Committee is Dr. E. N. Fox, M.A., Cleland House, Page Street, S.W.1.

It will be seen from the list of members of the Committee that the emphasis is laid upon physics and engineering. This is due to the urgency of the shelter and allied problems. But it is the Lord Privy Seal's intention that the work of the Committee should not be restricted to this aspect alone, and further members will be appointed to cover additional fields of research, as may be required. In so far as extra laboratory facilities may be required, it is hoped, as already indicated, to secure these in the Universities. But the Committee will also have at their disposal arrangements for full-scale trials impossible under University conditions.

The research work which is at present being carried out under the auspices of the Air Raid Precautions Department includes extensive experiments on earth waves resulting from explosions, the physiological effects of blast, as well as such matters as the protection afforded by obstructions, such as traverses in trenches, "zig-zagging" of trenches or entrances to shelters, and the value of buildings in shielding other buildings. Experiments and research in many other directions have been in progress for some time in conjunction with the Department of Scientific and Industrial Research, but notably on the measurement of blast pressures, particularly in connection with air-raid shelters. The reports on these experiments, which are extremely satisfactory, are about to be published.

The National Physical Laboratory is advising on problems of lighting, warning signals and steel helmets, in addition to many others, while the special research and experimental facilities of the fighting Services are continuously utilised, in regard particularly to high explosives and chemical defence.

Company Reports

Summerlee Iron Company, Limited.—Final dividend of 7½ per cent., making 12½ per cent.

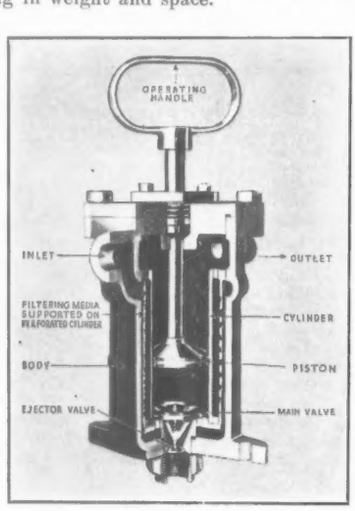
Howard & Bullough (Securities), Limited.—Net profit for the year to March 31, £46,044; dividend on the ordinary shares of 3¾ per cent.; carried forward, £1,235.

Ransomes, Sims & Jefferies, Limited.—Net profit for 1938, £65,270; brought in, £60,374; dividend on the ordinary stock of 7½ per cent.; to reserve, £25,000; to be carried forward, £52,144.

Meters, Limited.—Net profit for the year ended March 31, £25,160; brought in, £13,695; interim dividends, £6,241; reserve for N.D.C., £2,200; reserve for A.R.P., £5,000; final dividends of 2¾ per cent. on the preference stock and 6½ per cent. on the ordinary stock, making 5½ per cent. and 9 per cent. respectively; carried forward, £13,377.

The Newcon Filter

A useful filter of new design for the treatment of all types of oils and other liquids has been designed by Newcon Filters, Limited, of Slough. The Newcon filter, illustrated, is designed to give:—(1) Simplicity of operation; (2) momentary cleaning time without interruption of flow; (3) positive self-cleaning, the sludge and impurities being ejected from the filter and thus not being allowed to re-mix with the incoming liquor; (4) low back pressures, which ensure adequate flow, consequently impurities are not forced through or into the filter medium; (5) capacities are extremely high, and filter medium does not offer any restriction to normal flow; (6) the filter is of robust construction and compact design, giving a very definite saving in weight and space.



THE NEWCON FILTER, PISTON TYPE.

There are two main types, piston-cleaned and rotary. The piston-cleaned filter is a low-pressure type manufactured in sizes from ¼ in. to 2 in., and with capacities of 120 to 1,280 galls. per hr. This filter automatically indicates when cleaning is required by an upward movement of the piston handle, as the filter medium becomes clogged. Cleaning of the filter medium is by a reciprocating movement of the piston. The rotary-type self-cleaning filter is manufactured in a range of sizes from ¾ in. to 6 in., with capacities of 500 to 20,000 galls. per hr., and has been designed to deal with large quantities of liquid containing a high percentage of solid matter. It is especially suitable for handling lubricating and fuel oils, boiler oil, industrial oils and greases, water and factory effluents. Immediately the filter medium requires cleaning, a pressure alarm bell is automatically operated and one complete turn of the handwheel discharges all foreign matter.

THE ATLANTIC ENGINE WORKS of Wishaw have orders on hand which will keep the works well employed for several months. Last week the company despatched a large plant for margarine mixing, capable of turning out 200 tons a day. The firm has been in operation for 80 years, and its original activity was the manufacture of baking machines At the end of the War they started the manufacture of internal-combustion engines for marine and stationary purposes, and about ten years ago commenced work on the construction of high-speed Diesel engines for the Admiralty, War Office, and most of the principal steamship companies. The firm has also continued with the manufacture of baking machines, and it is believed that a "Morton" machine will be found in almost every bakery in the country. Mixing plant for the chemical industry and a special machine with a body made entirely of silver for mixing explosives are also constructed at the works.

Random Shots

A French reader, wishing to get his own back on last week's translation of "cow on the box," retaliates with a quotation from a letter which he swears came recently from an English friend. Amongst the furniture which this friend had been buying at country auctions was a very fine "poitrine de pantalons."

* * *

Apropos of France, the Editor tells "Marksman" that he paid a flying visit to Paris last week-end, to be with the French foundrymen, who were meeting for their annual conference. His "just one Eden and one Chamberlain" to the cloakroom attendant was greeted with loud guffaws, which shows how well versed in English politics are our French neighbours. That, however, is by the way, for he brought back with him a far better story from a French paper which proves how well they understand other countries' affairs, too. A Spanish journalist submitted his article to the censor, but the censor was a little worried over the inclusion of one paragraph. "I must ask my chief," said he, "before I can allow that to pass." Picking up the telephone, he said, "Hello, is that Rome?" And a voice replied "Ja!"

* * *

The notice board "Private Property" or "Trespassers will be prosecuted," so tantalisingly placed at the edge of the most promising looking bluebell woods, has long since failed to strike fear into the breast of the ardent flower picker, but a notice seen the other day surely takes the prize for craftiness. No threats were promised, no gentle entreaties to respect another's property, but just the bald warning, "Beware of snakes"! Whether genuine or not, few would care to make a personal investigation to test its veracity; and it is a fact that the wood in question looked as though nobody had dared to intrude for years!

* * *

An equally frightening notice, though this time unintentionally so, is the large printed slogan to be seen on Waterloo Bridge, "We must be prepared." One takes a hasty glance at the present flimsy structure and wonders how easy it is to swim in that cold cold water hampered by overcoat, umbrella and all the other appurtenances of everyday completeness.

* * *

With Whitsuntide upon us and the usual prospect of overcrowded roads, "Marksman" wishes that more people would take the excellent advice of Mr. Middleton, who entreats his listeners to "step on the spade a little more and on the accelerator a little less." Anybody who is lucky enough to be able to "get a man in for the rough" would do well to take the advice of the old Irish lady who said, "Sure, an' if it's a gardener you'll be needing, just look at his trousers. If they're patched at the knees, take him. If they're patched in the seat, begorra, have nothing to do with the fellow."

* * *

Lot 10 from the Barrington Hooper Collection.

Motorist (to Oldest Inhabitant outside village inn): "So you're 87! Well, I must say you don't look as though there's much wrong with you."

"Ah! That be just it, zur—thirst don't show."

"Hopkins," remarked the *nouveau riche*, as the superb butler swung open the front door for his exit, "I've 'ad a tiff with the mistress. Jest bang the door after me."

"MARKSMAN."

Applications of Gas Fuel for Foundries*

By A. E. WILSON

Iron foundries may appear to offer very little scope for gas fuel; there are, however, such jobs as cupola lighting, ladle heating, mould and core drying, and skin drying of floor or large moulds to which gas may be applied.

Mould and core drying will first be dealt with. It was for many years thought that temperatures of 500 to 550 deg. Fah. (260 to 287 deg. C.) were necessary for drying cores and core ovens, and very often only braziers were used with coke fuel which attained these temperatures. It is appreciated nowadays that the best method of evaporating water is by the rapid changing of the air around the work; clothes hung out to dry will dry quickest on a breezy day. Hot air can be produced by coke and, of course, this is

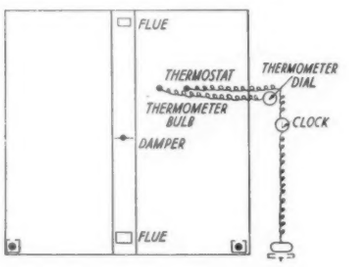


FIG. 1.—GAS-FIRED DRYING STOVE OF SPECIALLY-ADAPTED DESIGN.

being done; but if a temperature of only 260 to 287 deg. C. be required in the stove, why employ a source of heat, that is, a coke fire with air above and below the fuel bed, that has a temperature of probably 1,000 deg. C.? In the application of gas fuel to this job, conservation of fuel is quite simple by employing re-circulation, some of the moisture-laden air being leaked off and fresh make-up air drawn in. This cannot be easily arranged with solid fuel.

Although the running costs of such stoves with a gas-fired air heater are low enough to compete with solid fuel, especially in view of the shortening of the drying time, unfortunately the capital cost of the equipment, except in the case of very large ovens, or a battery of ovens, is rather disproportionate, in the sense that it is higher than those sums hitherto allocated to core and mould drying. Having this unfortunate state of affairs in mind, the author has

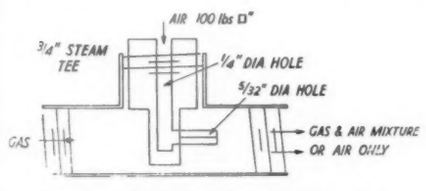


FIG. 2.—GADGET FOR REDUCING AIR PRESSURE.

accordingly sought to obtain this condition, *i.e.*, a large number of air changes at 204 deg. C., by natural convection.

The oven, 14 ft. by 10 ft. by 9 ft., was brick-built, and was used for both core and mould drying. Rail burners were placed along each side of the oven and a trough of 18-g. black iron sheet was fitted round each burner rail with the open ends of the trough protruding through the front and back walls. The oven had an existing chimney inside the back wall and openings were made in this flue at the top and the bottom. These two openings were made of such a size that their combined area was sufficient to deal with the products of combustion and approximately six air changes per hour. The effect was that all the air entering the oven was drawn through the zone of the flame and was spread evenly throughout the stove. This is shown in Fig. 1.

With this plant an oven load of approximately 2,400 lbs. of sand with 7 per cent. H_2O and 2,400 lbs. of boxes and racks was dried in 4½ hrs. with a gas consumption of 4,200 cub. ft. The temperature was controlled at 210 deg. C. by a rod-type thermostat and the oven was lit and extinguished by clock. The necessary drying time was first found by experiment, and thereafter (the load in the oven being always the same) the clock was set for a 4½-hr. period, *e.g.*, 7.0 p.m. to 11.30 p.m.

All foundrymen are familiar with the steel-cased core ovens with draw-out shelves, and because of this they are too orthodox to need comment. For those who may have experienced any trouble, here are a few figures for a four-shelf oven with shelves 10 in., 10 in., 1 ft. 1 in. and 1 ft. 4 in. deep, with loads of 1 cwt., 1 cwt., 1½ cwts. and 2 to 2½ cwts.; the maximum gas consumption of 350 cub. ft. per hr. cutting down to 150 cub. ft. per hr. *should* dry the whole contents in 1 to 3 hrs., according to the cross-sectional dimensions of the cores.

Cupola Lighting

The lighting of cupola fires is another job. A simple gas and air blast mixer using air from the cupola blower is connected to a suitable burner head which is inserted into the coke. The whole apparatus is either hinged or on a flexible tube, and the lighting takes about 10 min. with a gas consumption of 70 to 80 cub. ft.

A job which comes to mind—not usually associated with the foundry, but nevertheless a very important stage in production—is the welding of cast iron. Cast iron must be pre-heated before welding and sometimes heated after welding, although the latter comes under the heading of "heat-treatment," being normalising or stress relieving. A furnace using natural-draught gas burners, attaining a maximum temperature of about 850 deg. C., is all that is required. It can be of any size or section according to the work normally dealt with.

Skin Drying

The drying of floor moulds and the skin drying of moulds in general is a job for which gas is eminently suitable even directly applied. Flames of various lengths can be obtained with standard equipment, and if very long flames are required pressure air can be used, thus making possible flames four or more feet long. One of the snags of combustion equipment for gas is the provision of the necessary air; in a foundry the atmosphere is usually laden with dust, and if natural-draught equipment is used this dust is drawn into the injector, impairing its efficiency and gradually blocking it entirely. If it is decided to use air under pressure and a fan is suggested, the immediate remark is made that air is available, and further that no more pipes are wanted. Reluctantly accepting this state of affairs, after pointing out that compressed air is expensive, there is only one way of utilising it for combustion purposes. For combustion, a pressure of 8 to 16 in. W.G. is ample, so to reduce 100 lbs. per sq. in. down to this very low pressure calls for multiple-stage reducing valves or isothermal expansion through a small orifice. A gadget on these lines was designed, with the additional advantage that only one tube was required either for drying the moulds or blowing out dust, etc., for 100 lbs. per sq. in. is not required for blowing away a few specks of loose sand. This device is shown in Fig. 2.

Heating Ladles

Ladle heating, whilst not always appertaining in iron foundries, is becoming essential with the use of alloy cast irons. In steel foundries, brass, nickel and aluminium foundries, where pouring is not from crucibles, use must be made of hot ladles whether lined or unlined. Small ladles without stoppers can be inverted over an air blast burner, and with this system a 12 in. dia. shank can be heated to dull red heat—hot enough to prevent skulls with copper-zinc alloys—in about 15 min. with 30 cub. ft. of gas. This system also applies to unlined shanks for aluminium, although in this case air-blast combustion is not essential (Fig. 3).

Ladles with stoppers must be heated either on their sides or the right way up. In this case, the ladles being bigger, air-blast combustion is essential, but the flame must not be too keen or burning of the stopper will occur. Partial aeration will result in a large soft flame, which has

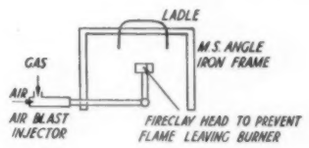


FIG. 3.—LADLE DRYING ARRANGEMENT.

the advantage of covering the whole bottom and sides of the ladle. A lined ladle, 3 ft. 3 in. dia. and 3 ft. 6 in. deep, for use with valve steel, was heated uniformly in 40 min. with approximately 1,200 cub. ft. of gas. With the method shown in Fig. 4, the ladle, on its side, is brought to the burner, which is firing through a wall so arranged that the top of the ladle fits against the wall except for the top six or seven inches of the diameter. If the ladle is heated the correct way up, the burner fires down through a canopy which is slightly smaller in diameter than the ladle; this canopy and burner are on a swivel joint and can be swung into position when required. The method of combustion is again air blast with a long flame.

Oil-Sand Cores

For the manufacture of oil-bonded cores it is quite usual to use dry sand; it is also preferable to use dry sand with carbohydrate bonds. The revolving-drum drier with the drum slightly inclined is a good example of an efficient apparatus, as with gas firing it is possible to drive off the water without raising the sand to very

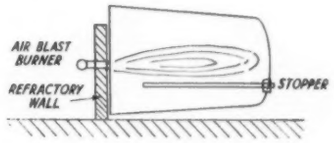


FIG. 4.—DRYING METHOD FOR LADLES WITH STOPPERS.

high temperatures. Some driers result in the sand leaving the machine at such a high temperature that it is several hours before it can be handled. This drum drier is necessarily mechanical and, of course, the same method is used for drying many other substances, *e.g.*, sulphate of ammonia at the gas works. A plant of the type shown in Fig. 5, producing 25 cwts. per hr. of dry sand from a wet sand with 9 to 10 per cent. moisture, has a gas consumption of 360 to 400 cub. ft. per hr.

A static drier, such as is shown in Fig. 6, either hand or mechanically fed, can be made quite simply, particularly when only small quantities are required.

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* Extracts from a Paper presented to the West Riding of York-shire Branch of the Institute of British Foundrymen.

Annealing Castings

The remarks concerning sand, cores, moulds and ladles apply to all foundries. Annealing of steel castings is a job particularly suitable for gas firing; the temperatures normally employed (up to 1,050 deg. C.) are easily attained and control is very simple. As an afterthought, the same plant will, of course, anneal malleable iron and alloy cast irons. Annealing is a cooling process; the heating up, provided the work is thoroughly soaked and not burnt, can be carried out quite quickly. It seems obvious, therefore, that the cooling should be done in a chamber separate from the heating chamber. There are several ways of doing this, dependent upon the size of the work. With heavy work, bogey-type furnaces are usual with three or more chambers. If there are three chambers, the first is for preheating, the second for soaking, and the third for cooling. The waste gases from the middle

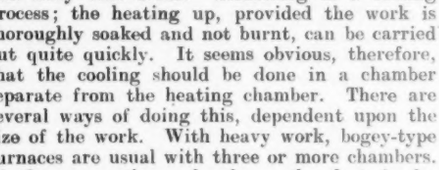


FIG. 5.—GAS-FIRED SAND DRYING PLANT.

chamber are used either in the preheating chamber, or in the cooling chamber, to retard the rate of cooling, or for both purposes. Consumptions in the region of 3,000 to 5,000 cub. ft. per ton are reasonable for steel castings. If the work is less in weight and more or less uniform in size, a multiple-bogey furnace can be used with, say, nine bogies, thus:—Door, four preheating; door, one soaking; door, four cooling; door. This can be arranged as a continuous job, for if one bogey is pushed in every 2 hrs., it gives an 18-hr. cycle, with 8 hrs.' heating up, 2 hrs.' soak, and 8 hrs.' cooling. In such a furnace the four doors are interconnected so that all lift simultaneously. Such a plant is shown in Fig. 7.

Non-Ferrous Metal Melting

Non-ferrous foundries, in addition to the applications already mentioned, offer that of melting. This has been tackled many times, and for many years, but it is thought that at

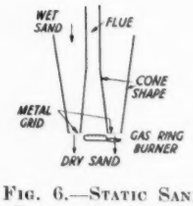


FIG. 6.—STATIC SAND DRIER, GAS FIRED.

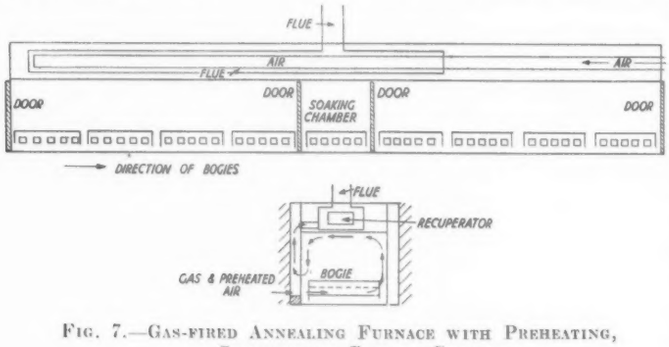


FIG. 7.—GAS-FIRED ANNEALING FURNACE WITH PREHEATING, SOAKING AND COOLING CHAMBERS.

last the gas industry has a job to offer. Speaking of the pit furnace with crucibles up to 200 lbs. brass capacity for lifting out, some foundrymen have talked glibly about consumptions of 4 cub. ft. per lb. and have attained this figure, but the melting time has been excessive. When the melting time has been adjusted the consumption will also be satisfactory. The whole question reduces itself to one of speed of heat input; the greater the B.T.U. input for a certain volume of combustion space, the faster the melting and the lower the number of cubic feet of gas per pound. In all this argument an adequate thickness of insulation is presumed. The ordinary pit fire with a burner firing tangentially round the bottom, using air at 1 lb. per sq. in., will melt 150 lbs. of brass pouring at 1,100 deg. C. in 50 to 55 min., with consumptions after the first melt of 4 cub. ft. and less per lb. This is not sufficiently fast for many people. If the thickness of insulation be increased, the face temperature of the refractory lining is increased, but also the temperature at the junction of the refractory and insulation rises, and this results in material breakdown. A way out of this difficulty is to build the furnace with outer insulation, then insulating refractory and then a thin coat of sillimanite. By this means the furnace dimensions are kept within reason and higher temperatures can be attained. In the case of a tilter it has the added advantage of decreasing the weight of the lining.

The next question is the B.T.U. input. More gas per hr. can be burnt if higher air pressures are used, for instance, and though 1 lb. per sq. in. has been cited, yet if 3 lbs. be used then the gas rate goes up. Unfortunately, the flame produced by using air at such pressures tends to cut into the furnace wall and into the crucible. Repairs to the lining and very poor crucible life preclude using air at pressures higher than 1 lb. How, then, is one to burn the quantities required to give rapid melting, together with the maximum lining life and the maximum heats per crucible? The answer is to have more than one burner port.

In America the job of melting was tackled seriously with great success. The lining mentioned above is used, in conjunction with at least three burners for pit furnaces or tilters. The following figures relate to a 4-cwt. tilter pouring at 1,250 deg. C.

	Time.	Gas consumption.
1st melt	79 mins.	4.4 cub. ft. per lb.
2nd ,,	57 ,,	3.0 ,, ,,
3rd ,,	55 ,,	2.9 ,, ,,
4th ,,	55 ,,	2.6 ,, ,,
5th ,,	52 ,,	2.6 ,, ,,
6th ,,	55 ,,	2.8 ,, ,,

This method of combustion results in longer lining life and very often doubles the number of melts per crucible. The gas consumptions cited above are for manufactured gas of similar value to domestically manufactured town's gas.

Another way of attaining higher temperatures in the combustion space is by the use of preheated air. This presents several difficulties, including the situation of the recuperator. The recuperator must be put near the waste gases, this being in the furnace casing. The size of the plant is considerably increased, and in the case of a tilter renders the machine almost impossible of manipulation. With pit furnaces the recuperator can be in the furnace casing between the refractory and the insulation, or in ring form round the top. In either case the second difficulty arises—that is of what material to make the heat exchanger, for the waste gases leave the furnace at anything up to 1,700 deg. C. No metallic recuperator will last long under such conditions, and if a refractory recuperator is used, bulk again becomes the difficulty, and the heat exchange is slow. The third difficulty is the burner; with preheated air it is not possible to use an injector, and the burner must be either a nozzle mixing type or a diffusion flame burner. In either case, using air at sufficiently low pressures to obtain any degree of preheat, the B.T.U. input of gas is lower than with the cold-air injector principle. In other words, higher temperatures in the furnace are gained, yet there is not a great deal of improvement in the melting time. Such plant is suitable therefore for melting copper-nickel alloys.

A furnace using recuperated air, based on a totally different principle from those just

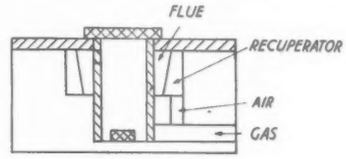


FIG. 8.—GAS-FIRED BALE-OUT FURNACE INCORPORATING RECUPERATOR.

described, is the natural-draft bale-out furnace so eminently suitable for aluminium die-casting. This furnace (Fig. 8) depends upon chimney draft, and each size of furnace has a definite minimum height of flue. The furnace has no injector—raw gas and preheated air being mixed in a burner tunnel.

The rotary barrel or open flame melter continues to have adherents; as this is a controversial matter only a few results will be quoted: (1) A 300-lb. semi-rotary furnace of 2,221 lbs. brass capacity worked at 5.9 cub. ft. per lb., including the first melt from ingot copper and additions; (2) 1,126,921 lbs. of brass, aluminium, etc., at an average of 6.83 cub. ft. per lb. for a long period of ordinary foundry conditions. A 300-lb. tilter should burn up to 1,200 cub. ft. per hr.

DISCUSSION

The CHAIRMAN (Mr. S. Carter) said Mr. Wilson had introduced a highly interesting topic, and it was unfortunate that the length of the Paper, and the fact that it followed the previous business of the evening (the annual general meeting) did not leave time for adequate discussion. Perhaps a discussion of the Paper could be arranged for some meeting in the next session.

MR. H. FORREST (past-President of the Branch) said he had found the lecture very interesting, and there were several points he would like to have raised; in the circumstances, he would wait in the hope that the opportunity would come at a later date.

MR. H. A. MACCOLL, B.Sc., moved, and MR. WALTER FEARNSIDE seconded, a vote of thanks to the lecturer.

MR. WILSON, replying, said he would be glad to answer questions or assist in discussion on any points members might care to raise on a future occasion.

THE CHROMIUM MINING AND SMELTING CORPORATION, LIMITED, which owns and has partially worked chrome ore in the Lake Obonga district of North-West Ontario, producing 191 tons in 1937, is erecting a preparation plant at Sault Ste. Marie. Two furnaces are ready, and the rest of the plant is now being completed.

Cracking of Ingot Moulds

EXTRACTS FROM SUB-COMMITTEE'S SECOND REPORT

(*Continued from page* 405.)

The Basic Causes of Cracking

Co-ordination, whilst proving a fruitful line of attack, cannot alone reveal the basic causes of the cracking of ingot moulds, and no true interpretation of results can be made without the application of first principles to a study of the mechanism of the process. Cracking depends on the magnitude of the stresses set up in the mould and on the mechanical properties of the mould metal at room and at elevated temperatures. It was shown in the first report that thin-walled moulds crack more easily than thick-walled moulds. This statement perhaps requires qualification.

Cracking is brought about by the combined effects of stress due to (1) the temperature gradient through the mould wall, and (2) the difference in temperature between parts of the mould remote from each other. Thin moulds attain a higher average temperature than thick-walled moulds, and consequently, if only partially filled or if possessing strengthening-ribs, they must be subjected to higher differences in temperature between remote parts and therefore be more highly stressed.

The coefficient of expansion has a direct influence on the stresses, whilst the thermal conductivity, the specific heat and the specific gravity of the mould metal, by their influence on the temperature gradient, are also of importance. Only a very imperfect picture of the temperature gradients in the mould wall can be obtained, however, from the constants referred to above, as other factors play an important part. Although qualitative deductions of this nature may readily be drawn, many of the data are lacking to enable quantitative statements to be made.

The present programme of the Sub-Committee is largely directed to fulfil these requirements: First, in order to obtain a more accurate knowledge of the temperature conditions in the mould wall, an experimental investigation has been undertaken of the time-temperature relations at a large number of points in the wall of a slab mould during the casting of three consecutive ingots. It is intended that the results which are set forth below shall be subjected to mathematical analysis, in order to determine the stresses set up. This information, together with the results of experiments now in progress on the mechanical and physical properties of mould metal at room and at elevated temperatures, should assist in providing a reasonably accurate conception of the mechanism of cracking.

TABLE I.—*Further Details of the Tests.*

Test.	Steel analysis.	Teeming temp. (uncorrected).* Deg. C.	Temp. of mould (approx. room temp.). Deg. C.	Wind.	Weight of ingot. Cwt.	Teeming time. Min.	Teeming remarks.
	Per cent.						
1	C 0.17, Si —, Mn 0.59, S 0.056, P 0.03	1,430	15	Slight westerly breeze on broad side under test.	208	3.2	Good stream.
2	C 0.19, Si —, Mn 0.64, S 0.04, P 0.038	1,430	19		207	3.25	Good stream.
3	C 0.15, Si —, Mn 0.53, S 0.044, P 0.043	1,440	0	Cold east wind on broad face not under test.	208	2.75	Nozzle cut out a little.

* Cambridge disappearing-filament pyrometer.

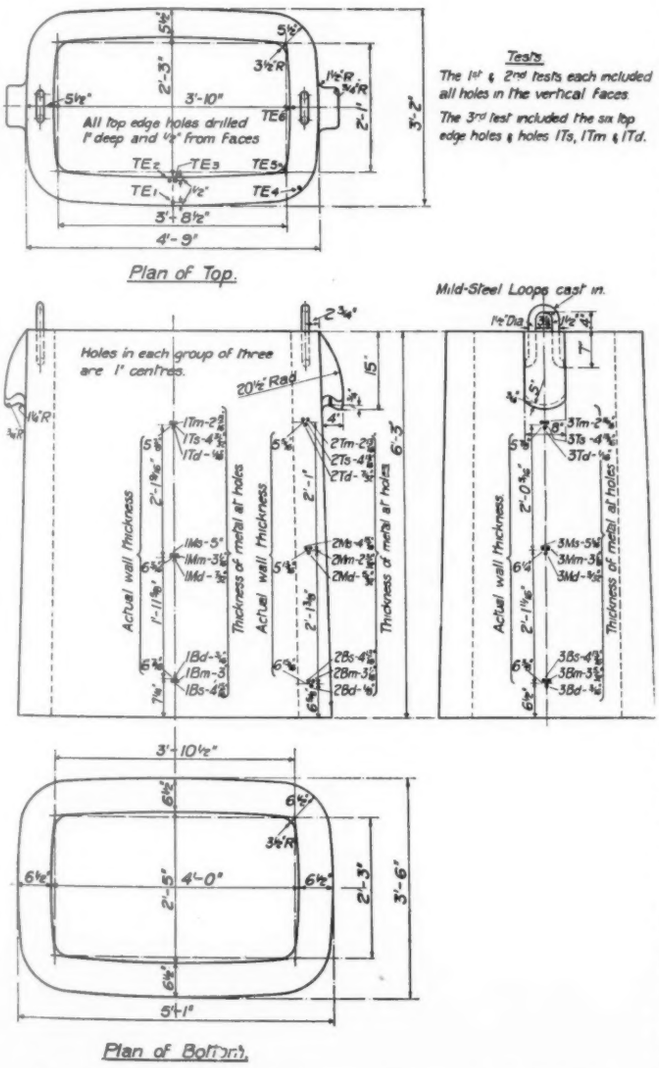

Tests.
The 1st & 2nd tests each included all holes in the vertical faces.
The 3rd test included the six top edge holes & holes 1Ts, 1Tm & 1Td.
All top edge holes drilled 1" deep and ½" from faces
Plan of Top.
Mild-Steel Loops cast in.
Holes in each group of three are 1" centres.
Actual wall thickness
Thickness of metal at holes
Plan of Bottom.

FIG. 3.—THE 10-TON SLAB MOULD USED IN THE EXPERIMENT.

Determination of the Temperature Gradients in the Wall of a Slab Mould

Through the courtesy of a member firm of the British Iron and Steel Federation, a 10-ton slab mould of simple design and in general use by this firm was placed at the disposal of the Sub-Committee. This type was chosen for the experiment since it was prone to premature failure by cracking.

Details of the mode of failure and life of this type are as follows:

		Failure by cracking.			
			Broad side.		Narrow side, vertical.
No. of moulds.	Life.	Failure by crazing. Per cent.	Vertical. Per cent.	Horizontal. Per cent.	Per cent.
88	87	48	42	8	2

Four ingots were made prior to the experiments in order that any material adhering to the working face as a result of moulding or dressing used in the foundry, should be removed. A scale drawing of the mould is given in Fig. 3, showing the location of the holes and the thickness of metal between the bases of the holes and the working face. Each hole is referred to in code, both on the drawing and subsequently in the text. The key to the code is given for the convenience of readers as follows:—

Nos. 1, 2 and 3 denote the broad-side, corner and narrow-side holes respectively.

T = top. s = shallow.
M = middle. m = medium.
B = bottom. d = deep.

Holes in the top edge are referred to as TE and are numbered 1 to 6.

The holes in the wall were made as small as practicable to minimise any possible interference with the normal temperature gradients. These were drilled ¼ in. in dia. to depths distant from the working face of ⅛ in., 3 in., and 5 in., and were made flat at the base.

Subsequent accurate measurement, however, revealed small discrepancies, the effect of which can be determined for any accurate calculations by plotting the temperature against the distance from the working face at any given time. The temperature at any given distance from the working face can then be obtained by interpolation or extrapolation.

Temperature readings with time were obtained by means of three 10-point direct-reading millivoltmeters and previously synchronised stop-watches, each instrument requiring two observers.

Prior to the experiments the couples were tested at the temperature of molten salt, and afterwards both couples and instruments were checked against a standard National Physical Laboratory rare-metal couple in conjunction with a potentiometer.

Details of the three tests, which were carried out under as closely similar conditions as possible, are as follows: The mould was so situated that it was not affected by any outside source of heat; the narrow side under test was 2 ft. 3 in. from the asbestos screen protecting both the instruments and the observers, while the other three sides were open to the shop. The ingots, all of semi-killed type, were car-cast and teemed direct through a 1-in. clay nozzle to within 6 in. of the top of the mould in all three cases, the fourth ingot of the three heats being cast for the experiments. The weights of the mould and well bottom were 8 tons 6¾ cwt. and 2 tons 6½ cwt., respectively. The average analysis of the mould metal drilled from the experimental holes was:—T.C, 3.7; C.C, 0.18; Si, 2.05; Mn, 0.67; S, 0.070, and P, 0.046 per cent. Separate analyses showed little or no heterogeneity, except with respect to a total carbon of 3.28 per cent. in the average of the three holes at the bottom of the broad face. Further details are given in Table I.

A crack hardly discernible at room temperature was noticed in the middle of the bottom of the broad face prior to carrying out the experiment. During the first test, the crack appeared to cross hole 1 B*m* and extended to a point 2 in. above, whilst in the second and third experiments it increased in length by 2 in. in each test, opening out to a maximum of approximately $\frac{3}{16}$ in. at the bottom 30 to 35 min. after teeming commenced. It closed considerably on the completion of each test and completely at room temperature.

Time-temperature graphs recording the observations were made at the various positions on the mould during the experiments.

It is intended in the present report to make only a preliminary examination of the time-temperature curves, and to proceed with the mathematical consideration of the data at a later stage.

The first and second tests were carried out each on the 27 vertical positions, including the nine broad-face, the nine corner and the nine narrow-face holes. The third test included the six holes in the top edge of the mould, as well as holes 1T*s*, 1T*m* and 1T*d* for comparison. The temperature of each hole was taken every minute, each instrument permitting of nine readings to the minute or one in approximately 6½ sec.

In order to check the accuracy of the dry method of contact employed between the hot junction and the mould, the time-temperature curve of hole TE2 containing mercury was compared with that of hole TE3. The results were identical. The zero of the graphs in all cases has been taken at 6 min. before teeming commenced. The time taken to teem each ingot has already been given in Table I. The maximum temperatures attained at each hole and the times from the commencement of teeming are given in Table II.

The approximate intervals (as judged by the discontinuities in the time-temperature curves) between the time when each deep hole was covered with liquid metal and the time at which separation of the ingot from the mould took place, together with the temperature of the mould at separation, are given in Table III.

It was observed that there was no sharp indication in the graphs of a separation of the ingot from the mould on the broad side, such as there is on the corner and narrow side. This may be due to a number of factors, including:—

(1) The greater tendency of the broad side of the mould to bend inwards, thus possibly bringing pressure to bear on the broad side of the ingot.

(2) The greater influence of ferrostatic pressure on the broad-side skin of the ingot than on the corner or narrow side.

(3) The lesser total lateral contraction of the ingot and the lesser lateral expansion of the mould between the two broad sides, compared with those between the two narrow sides.

(4) A continuous peeling-off rather than an abrupt separation of the ingot from the mould.

The greatest temperature differences at adjacent holes through the mould wall, which are between the medium and deep holes, together with the times after commencement of teeming, are given for the first and second tests in Table IV.

The greatest temperature differences taken vertically are between the top edge and the top face holes. These are given, together with the times after the commencement of teeming, in Table V.

The Sub-Committee do not propose at this stage to deal with the stress calculations based on these experimental results, but they have instituted a Panel to give full consideration to the mathematical aspects of the problem. The following tentative remarks are made, however, to indicate the inferences that can be drawn.

The stresses produced are, in general, compressive at the inner surface and tensile on the outer surface of the mould. The largest temperature differences occur very shortly after filling the mould, namely, between 4 and 14 min. Approximate stress calculations indicate that, in the middle of the broad side of the mould at this period, the tensile stress at the outer surface may reach values approaching the tensile strength of the iron. The compressive stress on the inner surface is higher than the value of the tensile stress on the outside, and it is, therefore, fortunate that cast iron has a higher compressive than tensile strength.

The temperature differences between inside and outside surfaces, and hence the resulting stresses, are of the same order in the middle of the narrow side as for the middle of the broad side, but at the top of the mould these are very

(*Continued on page* 421.)

TABLE II.—*Maximum Temperatures Attained.*

	Hole.	Temperature. Deg. C.			Time after teeming commenced. Min.		
		1st test.	2nd test.	3rd test.	1st test.	2nd test.	3rd test.
Deep.	1T*d*	818	790	801	89½	87	88
	1M*d*	845	847	—	107½	123	—
	1B*d*	759	787	—	101	116	—
	2T*d*	621	613	—	112	109½	—
	2M*d*	667	672	—	147½	160½	—
	2B*d*	554	571	—	138½	136½	—
	3T*d*	720	714	—	81½	86½	—
	3M*d*	786	786	—	107	117	—
	3B*d*	634	640	—	78	116½	—
Medium.	1T*m*	698	680	683	104	130	137½
	1M*m*	744	750	—	152	154½	—
	1B*m*	663	684	—	131	134	—
	2T*m*	552	543	—	132	130½	—
	2M*m*	611	617	—	144	168	—
	2B*m*	522	532	—	148½	153	—
	3T*m*	624	615	—	110½	113½	—
	3M*m*	686	690	—	140	143½	—
	3B*m*	584	589	—	118	128	—
Shallow.	1T*s*	631	621	623	120	125	118
	1M*s*	688	692	—	145	145	—
	1B*s*	611	631	—	146	135	—
	2T*s*	499	489	—	136	154	—
	2M*s*	563	569	—	145	169	—
	2B*s*	494	509	—	145	154	—
	3T*s*	580	574	—	114	115½	—
	3M*s*	636	639	—	145	160	—
	3B*s*	547	553	—	130	122½	—
Top edge.	TE1	—	—	360	—	—	138
	TE3	—	—	368	—	—	118½
	TE4	—	—	316	—	—	139
	TE5	—	—	321	—	—	139
	TE6	—	—	320	—	—	130

TABLE III.—*Time of Ingot Separation from the Mould.*

Hole.	Approx. interval. Min.	Temp. at separation. Deg. C.	Hole.	Approx. interval. Min.	Temp. at separation. Deg. C.	Hole.	Approx. interval. Min.	Temp. at separation. Deg. C.
1T*d* ..	No indication of separation.		2T*d* ..	3	250	3T*d*	15	520
1M*d* ..			2M*d* ..	2	210	3M*d*	13	560
1B*d* ..			2B*d* ..	1	190	3B*d*	9	500

TABLE IV.—*Greatest Temperature Differences through the Mould Wall.*

Location of holes.	Greatest temperature difference between medium and deep holes.		Time after start of teeming. Min.	
	1st test.	2nd test.	1st test.	2nd test.
1B	375	325	4	4
1M	340	260	5	6
1T	400	380	5	4
2B	180	170	2	2
2M	165	170	3	2½
2T	180	180	5–6	5–6
3B	260	280	5	5
3M	360	360	3–4	4–5
3T	250	290	3	5

TABLE V.—*Greatest Temperature Differences taken Vertically.*

	Third test. Broad side.	Comparison between first and third test.	
		Corner.	Narrow side.
Inner face holes	TE3 and 1T*d*	TE5 and 2T*d*	TE6 and 3T*d*
Greatest temperature difference. Deg. C.	455	312	430
Time after teeming. Min.	50–60	100	80
Outer face holes	TE1 and 1T*s*	TE4 and 2T*s*	—
Greatest temperature difference. Deg. C.	270	180	—
Time after teeming. Min.	90–130	140	—

High-Duty Cast Irons*

BY H. J. READ.

The last quarter of a century has brought increased demand for what are now known as high-duty cast irons. The older types of foundry irons definitely had their limits of application in engineering and other metal-absorbing industries, but the newer types of ferrous alloys are most certainly now well established, and are daily finding new users.

The chief improvements effected in cast iron by the use of alloys are:—Refined grain with better wear resistance, machinability, strength and pressure tightness, heat and corrosion resistances and non-magnetism. The alloying elements used to achieve these qualities are Ni, Cr, Si, Mn, Cu, and to a smaller degree Mo, Al, and Ti. It is hardly necessary to add that only the best-quality base materials should be used, and pig-iron be purchased with a certificate of chemical analysis, each new consignment being subjected to a laboratory check.

While many of these irons may be produced with some degree of success from the cupola, the closer control obtainable by the use of the crucible, rotary, reverberatory or electric furnaces gives much better results. For instance, it is obvious that a charge of metal melted in either of these units (protected as it is from oxidation by a covering of slag and remaining in the furnace until the correct degree of superheat has been obtained) must give a truer mixture than can be obtained from a cupola, where there is a tendency for the most fusible elements in perhaps two or more charges to be melted and tapped before some of the more difficult portions of a charge, such as steel, nickel and chrome.

It is often desired to make small Ni or Ni-Cr additions to cupola metal, and this may be effected quite satisfactorily at the spout by using "F" nickel shot and/or ferro-chrome in a finely-crushed form. This form of Ni contains about 5 per cent. Si which reduces the melting point to about 1,260 deg. C. This reduced temperature serves to illustrate how important cupola control really is, as the metal must be tapped hot. Even under good conditions the additions will cause a considerable decrease in temperature, and no time must be lost in pouring. A reasonable limit to these "at the spout" alloy additions is about 2 per cent.

In ordinary cast irons with T.C approximating the eutectic, lowering the Si will raise the proportion of C.C. The lowering of the Si to about 1 per cent. represents a reasonable limit, as under this amount chilling will occur. Generally speaking, it is only when the T.C is lowered (provided the Si is raised in proportion in order to maintain greyness) that high strength is obtained.

Difficulties Due to Low Carbon

Low-carbon mixtures (with almost invariably low P) have a shorter freezing range and solidify at higher temperatures than ordinary cast iron, therefore causing difficulties in founding. To produce sound castings free from gas-holes the metal must be cast at a higher temperature; therefore the moulding sand used must be more refractory and at the same time more permeable than that used for ordinary work. There is much to be said for the use of dry-sand moulds. Not only is there less risk of blows and gas-holes, but, in certain types of castings, the less-yielding nature of the mould will, to some extent, tend to restrict the graphitic expansion of the solidifying metal, thus producing a tighter-grained casting. Of course, not all troubles due to openness of grain can be cured by simply drying a mould.

Although nickel in small quantities certainly helps to maintain granular uniformity in changing sections (providing proportional reductions of silicon are made) there are numerous types of castings that need feeding. The use of a feeding rod has very little to commend it in dealing with alloy irons, as the feeder metal is actually liquid for such a brief time before it becomes pasty that metal is very easily pulled out. Varying sizes of self-feeders are usually employed, while uniform cooling of sudden changes of section may be effected by the use of denseners. There are certain types of alloys, however, where denseners should not be used if the casting has ultimately to be machined.

Contraction allowances on patterns used for producing castings in high-nickel alloys should be slightly more than for ordinary cast iron, although in the case of a job with many cores this is not so necessary, as the expansion of the cores will tend slightly to decrease the normal amount of solid contraction.

* Short Paper presented to the East Midlands Branch of the Institute of British Foundrymen.

Cracking of Ingot Moulds

(*Continued from page* 420.)

much greater for the broad side than for the narrow side. The greatest temperature difference observed occurs at the top of the broad side.

As the mould heats up, the temperature distribution across the section of the mould wall becomes more linear and the tensile stress at the outer surface becomes more nearly equal to the compressive stress at the inner surface. There appears, indeed, to be a stage shortly after the time when the maximum temperature difference is observed when the tensile stress on the outside is increasing while the compressive stress on the inside is decreasing. It is at this stage that the conditions, for the mould in question, appear to be the worst as regards the magnitude of the stresses which may cause cracking of the mould. The problem is, however, complicated by the temperature variations both along the length and round the periphery of the mould.

(To be continued.)

Estimation of Sulphur in Solid Fuels

About a year ago DR.-ING. A. SEUTHE, of the Fuel Laboratory of the Dortmund-Hoerder Hüttenverein at Dortmund, published details of a laboratory method for the estimation of sulphur in solid fuels by combustion in a stream of oxygen. The method has now been exhaustively tested on all grades of coal, coke, breeze, and pyrites at a number of German collieries, the results of which are reviewed by the author in a recent issue of "Glückauf." The chief advantages of the method lie in its great rapidity and the more consistent accuracy obtainable as compared with the standard method using Eschka mixture. By combustion in oxygen, the whole of sulphur in the fuel is converted to either sulphate or sulphite, the dioxide and trioxide being passed into a hydrogen-peroxide solution; the sulphuric acid formed is titrated with caustic soda. Although the whole of the sulphur is converted to an oxide, it appears that a deposit may be obtained at the end of the reaction tube, which in the case of coke has been found to contain a maximum of 0.005 per cent. of S and with coal at most 0.02 to 0.03 per cent. S; it is, however, not difficult to maintain the error within these limits. The temperatures at which oxidation is effected are 1,200 to 1,250 deg. in the case of coke and at about 1,350 deg. with coal. With coke the reaction is complete within 8 mins., while with coal heating is carried out in two stages to ensure complete combustion of the volatile matter, and also takes only a total of 8 mins. The weight of sample taken in each case is 1 grm. A table showing the results of this method as compared with the Eschka method covers coals from 0.95

(*Continued at foot of next column.*)

(*Continued from previous column.*)

to nearly 5 per cent. sulphur, coke with around 1 per cent. S, lignites with also about 1 per cent. of S, and various pyritic products from 17.70 per cent. to nearly 52 per cent. of S. The agreement in repeats of the combustion method is very close, and the S values obtained are practically identical with those obtained by the Eschka method, indicating that the simplified procedure and the greater speed with which an estimation by the oxidation method can be carried out do not result in a lower degree of accuracy. Experimental details of the application of the method to coal, coke and breeze are given in the article.

Titanium in Cast Iron

A summary of published information on "Titanium and its Effect upon Iron and Steel" has been prepared by DR. L. NORTHCOTT and included as Section V of the Second Report of the Alloy Steels Research Committee which was presented to the Annual Meeting of the Iron and Steel Institute held in London recently. Some extracts relating to cast iron are appended.

The effect of titanium on cast iron has already been briefly reviewed by the British Cast Iron Research Association, and only brief mention need be made here. Numerous references occur in the literature, starting with the pioneer work of Rossi, which has recently been summarised. Although there is much conflicting evidence, the addition of titanium to cast iron appears, in general, to be beneficial. In a number of instances this has been explained as being due to its deoxidising or similar action, and sometimes to its grain-refining effect. Differences of opinion have been expressed as to the actual influence of titanium on the carbide equilibrium, and it is probable that the graphitising or carbide-forming effect will depend upon the amount of titanium present. Small quantities of titanium appear to act like silicon or aluminium in facilitating the formation of graphite, although the titanium itself, according to Comstock, is present in cast iron in the form of carbide or cyano-nitride. Challansonnet prepared a series of low-carbon cast irons (2.1-2.3 per cent. of carbon, 0.8-0.9 per cent. of silicon) containing 0-1.93 per cent. of titanium in a high-frequency induction furnace by adding ferro-titanium (27 per cent. titanium) made by the alumino-thermic process. He found that the irons could be divided into three groups: (*a*) white irons containing up to 0.8 per cent. of titanium, the hardness gradually decreasing from 550 to 395 Brinell with increasing titanium, (*b*) mottled irons containing from 0.8 to 1.3 per cent. of titanium, the presence of free carbon resulting in a rapid decrease in hardness from 395 to 220 Brinell, and (*c*) grey irons containing from 1.3 to 1.93 per cent. of titanium in which the carbon tended to be precipitated wholly in nodular form and the hardness gradually rose from 220 to 317 Brinell. Titanium sharply raised the pearlite transformation point, and was considered to affect iron in the same way as does silicon—titanium and silicon being similar chemically—and both favoured the formation of graphite during solidification as well as during annealing.

Hofmann and Schrader have recently illustrated the titanium-carbide constituent in cast irons; the carbide occurs in the form of hard greyish-white cubes, which were separated out by solution and examined by X-ray analysis. Kalashnikov, examining the effect on cast iron of chromium, titanium and vanadium added together, found that their presence improved the iron by refining its structure, forming carbides and completing the deoxidation; for grey iron the titanium content should not exceed 0.2 per cent.

Influence of Form and Scale on Strength

In a recent Bulletin* of the University of Wisconsin, an investigation by R. J. Roark, R. S. Hartenburg and R. Z. Williams is described, which is of major importance to structural designers in cast materials. The influence of form and scale on the strength of structural members made from brittle materials has been studied in a wide variety of instances, and the results deserve attention. The investigation can be divided into two main parts. The first of these deals with the factor of stress concentration, and the second with the factor of structural form.

Cast metals widely varying in degree of ductility were selected for the first part of this investigation, and tests were also made on plaster and bakelite. The plaster was chosen to test the validity of conclusions previously reached by the authors, that no common metal was more susceptible to notch effect than plaster, and that, therefore, the values of stress concentration found for plaster could be used as a conservative estimate for the effect of stress raisers on the strength of metallic parts. The bakelite was included to ascertain whether scale effect was absent in a non-crystalline material. Tests were made in tension, bending, compression and torsion under static, impact and repeated loading, using conventional types of form irregularity.

For the second part of the investigation — of rupture and form factors—only plaster and cast iron were used. The rupture factor (N), defined as a ratio of the fictitious maximum tensile stress at fracture to the ordinary tensile strength of the material, primarily depends on the form of the part and the manner of loading, and secondarily upon the formula used for calculating the stress. The form factor (F) is similar and is defined as the ratio of the maximum breaking stress to the modulus of rupture of a standard section. For instance, a ring in compression is compared with a standard rectangular beam, and for torsion any prismatic bar is compared with a solid circular section.

As the main conclusions of this report are of practical interest to the designer, it would be well to quote the more important of them here.

Effect of Stress Concentration

(1) A stress raiser causes as much reduction in strength when present in the original casting as when formed by machining.

(2) In the case of a machined notch a very smooth finish results in less strength reduction than that produced by a very rough finish.

(3) The relative sensitivity of cast metals is different for different stress raisers and different for different types of loading.

(4) The sensitivity to notch effect is practically the same under impact as under static loading.

(5) For geometrically similar specimens the static stress concentration increases with the scale. Tests on bakelite tend to indicate that this scale effect is absent in an amorphous material.

(6) For practically all forms of stress raiser and conditions of loading, it was found that plaster gave higher values of stress concentration than any other of the materials investigated. Hence it is probably safe to assume that the sensitivity of any structural metal is less than that of plaster, and that the effect of stress raisers on the strength of castings can be conservatively predicted from tests on plaster models.

Under (5) above it has been long realised by the designers that an allowance must be made for the effect of stress concentration in designing large-size members subject to fatigue, but this effect of size has not been emphasised in the design of castings for use under static conditions. Another word of warning is given under (3), which points out the danger of regarding one cast material as being more sensitive to stress raisers than another, no matter what the form of the member or the stress conditions.

Rupture and Form Factors

(1) For a given material the rupture factor increases with the degree to which the high stresses are localised, and has its largest values for conditions characteristic of stress concentration.

(2) For an element of any form the rupture factor for plaster is smaller than that for cast iron. Hence the strength of an iron casting can be conservatively deduced from tests of plaster models.

This report can be recommended to the notice of all structural designers as a guide to reconsideration of factors of safety that may be in current use with them in the design of cast structural members, and it should prove a useful addition to the design office.

* Bulletin of the University of Wisconsin. Engineering Experiment Station Series, No. 84.

Steel Prices Maintained

CHEAPER HEMATITE IRON

Prices of the main steel products are to remain unchanged after the end of the present period of stabilisation on June 30 until October 31 next. Hematite prices will be reduced by 5s. per ton. The only increase will be in acid steel billets and products rolled therefrom, which will be 5s. and 6s. higher respectively. These decisions, which have been reached by the Associations concerned, are in conformity with recommendations of the British Iron and Steel Federation, and are with the concurrence of the Import Duties Advisory Committee.

The prices of the products covered by the associations of basic pig-iron producers, Scottish, Midland and Welsh, and North-East Coast steelmakers, joist makers, soft basic billets, basic special steel billets, free-cutting steel billets, forging, drop forging and stamping blooms, slabs and billets, and sheet bar makers, will be maintained at their present level during the period June 30 to October 31 next, subject to the proviso in all sales and contracts that deliveries after October 31, 1939, will be at Association prices then ruling.

The National Association of Hematite Pig-iron Makers announces that the price of all qualities of hematite pig-iron will be reduced by 5s. per ton.

The price of acid steel billets (other than silico-manganese) of re-rolling or forging quality, which is controlled by the Siemens Martin Acid Steel Billet Association, will be increased by 5s. per ton. The National Association for Rolled and Re-Rolled Steel Products announces that the price of products rolled from Siemens Martin acid billets, other than silico-manganese quality, will be increased by 6s. per ton, the prices of all other products covered by the Association being maintained at their present level.

(*Continued from next column.*)

coke have practically no effect on the temperature, as the extra coke is burning above the melting zone with the formation of carbon monoxide and the absorption of heat from the rising gases. In the writer's opinion, peculiar variations in metal temperature are more often due to changes in metal section and the size and quality of the coke than to any other cause.

Great stress is sometimes laid on the use of the correct number of tuyeres, and also their size and shape, with the object of producing a soft blast, but surely it is reasonable to infer that the coke inside the cupola will spread and soften the blast, no matter what tuyeres are used? If this be correct, a more important point is that the tuyeres should be designed to deliver the desired blast volume into the cupola with as little resistance as possible.

As the limits of this Paper are strictly confined, the writer concludes with the hope that the unorthodox character of some of the views expressed herein will not prevent foundrymen from examining them critically.

Notes on the Cupola*

By J. Dearden.

The activities within a cupola can be divided into (*a*) the chemical processes associated with the combustion of coke, and (*b*) the physical change accompanying the melting of metal, and much confusion is avoided if these are considered separately.

The melting rate of a cupola depends primarily on the combustion rate of the coke, and this in turn depends on the weight of oxygen blown in per unit time. It is customary to measure the blast by volume, and if this and other factors be kept constant, a constant melting rate will result. But constant blast volume does not necessarily ensure the blowing into the cupola of a constant weight of oxygen per unit time, as the density of air varies with the atmospheric pressure and temperature.

Special cupola fans are available which allow for atmospheric variations and deliver a constant weight of air, but in spite of this refinement a constant melting rate cannot be guaranteed unless the metal-to-coke ratio is also kept constant. If this ratio is reduced by adding extra coke with the object of increasing the metal temperature, or raising the bed, extra time will be taken up by the combustion of this additional coke, and melting will be slower.

Combustion Rate as a Basis

The best melting rate for a cupola is said to be 10 lbs. of metal per sq. in. of cupola bore per hour, regardless of whether the cupola is to operate with a metal-to-coke ratio of 6 to 1, or 16 to 1. In the writer's experience the melting rate can safely be varied over a wide range below, if not above, this empirical figure, and he would prefer to take the combustion rate rather than the melting rate as a basis when deciding the proportions of a cupola, its tuyeres and air supply.

The theoretical quantity of air required for the complete combustion of 1 lb. of coke is approximately 140 cub. ft. This and even greater volumes of air are sometimes prescribed for cupola practice, despite the fact that combustion is far from complete in the ordinary cupola. The stack gases often contain 10 per cent. carbon monoxide, which means that each pound of coke has only consumed 110 cub. ft. of air. In the writer's opinion it is impossible to alter the air-to-coke ratio by variations in blast volume in an ordinary cupola except by extreme over- and under-blowing, as any change in the volume rate will have its corresponding change in the combustion rate, leaving the air-to-coke ratio unaltered. In other words, a blast volume meter may be used to control the combustion rate, and through this the melting rate, but it cannot alter the chemistry of combustion. The latter is, however, affected when more than one row of tuyeres are used.

Although the height of the coke bed may be fixed at the beginning of the run, it does not necessarily remain constant throughout the run, but will burn down to some level of its own determined by combustion and melting conditions. A change from light to heavy section metal in the charges will lower the melting zone and therefore the bed. Similarly, a sudden reduction in the blast will bring certain combustion conditions nearer the tuyeres, and thus lower the melting zone and the bed. A high bed can only be maintained by working with a low metal-to-coke ratio, and an occasional extra charge of coke will only raise the bed momentarily before it burns away, leaving the bed the same height as before.

Within limits, metal temperature is proportional to coke ratio. If the metal is very dull, increasing the coke will raise its temperature, but a point is reached when further increases in

(*Continued in previous column.*)

* Short Paper read to the East Midlands Branch of the Institute of British Foundrymen.

Castings for the British Gas Industry

By F. WHITEHOUSE

[Official Exchange Paper of the Institute of British Foundrymen presented to the Cincinnati Convention of the American Foundrymen's Association]

The gas industry, it has been aptly said, was born in a cast-iron retort and the cave shown in Fig. 1 was perhaps fittingly the "laboratory" in which Murdoch experimented in coal-gas making in his mother's iron teapot and iron kettle.

Descriptions of the retorts used when the great adventure of lighting Westminster with gas was entered upon differ, but in the "Day Books" of the author's firm there are despatch entries of retorts sent to the original Westminster Gas Light & Coke Company, though without details of size and shape. Fig. 2 is an example of such entries. From then to the present day the records reflect all phases of gas production plant, and it is of the foundry's connection with these that the author is to write.

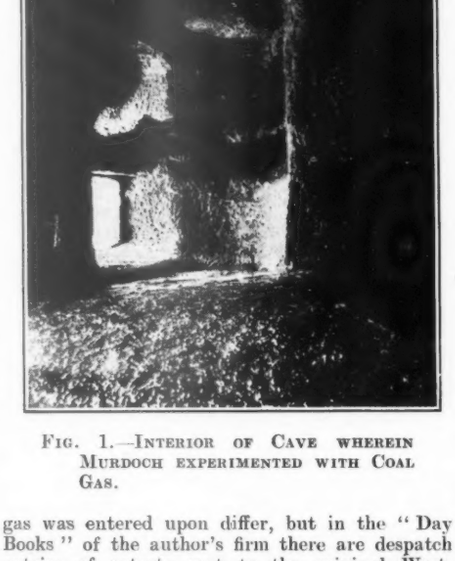
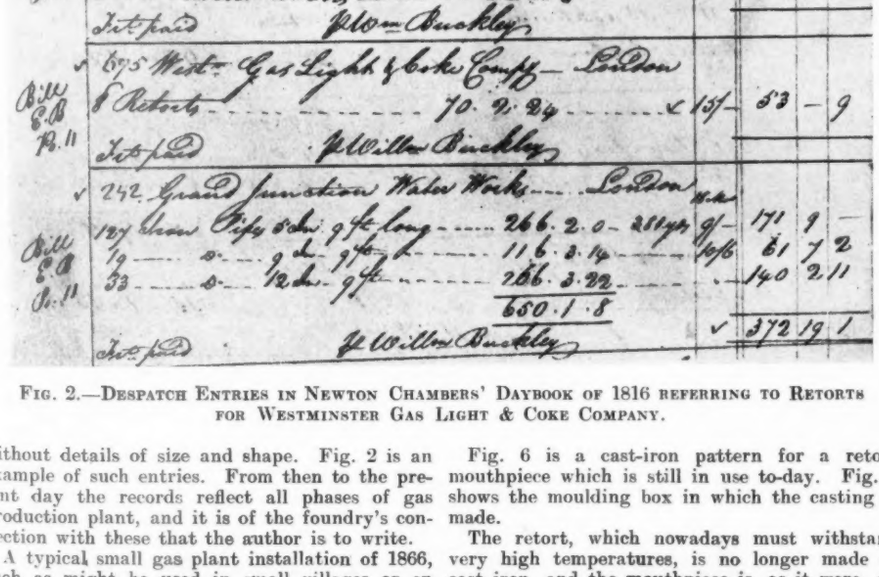


FIG. 1.—INTERIOR OF CAVE WHEREIN MURDOCH EXPERIMENTED WITH COAL GAS.

A typical small gas plant installation of 1866, such as might be used in small villages or on the estates of such people as the Duke of Devonshire or Earl Fitzwilliam, who often on their country estates had gas plants of their own, would incorporate the type of retort shown in Fig. 3. The moulding box is illustrated in Fig. 4, and the core box in Fig. 5. It should be mentioned that the shape was often a plain D rather than the hump-back variety illustrated here, and round ones were also used.

The retorts were cast vertically with the flange at the bottom. The core box, in the case of D shapes, was a cast-iron cradle of the correct shape. The procedure was first to wrap straw rope round a D-shaped barrel, line the cradle with loam, bed the wrapped barrel in, and make the top shape by means of a wood strickle. The whole was then put to dry, and after drying the core was taken out of the cradle and blacked. The iron used for these retorts was phosphoric, but of the cold-blast variety, and made from local ironstone.



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283. Edwd Bunn ..... London
1 Iron Bookcase fitted with folding doors
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Int. paid pr Wm Buckley

✓ 675 West.r Gas Light & Coke Comp.y — London
8 Retorts ..... 10. 2. 24 ..... ∠ 15/- 53 — 9
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127 Iron Pipes 8 in. 9 ft. long ..... 266. 2. 0 — 28 1/4 p.c 9/- 171 9 —
Bill E.B P. 11 12 ... 8 ... 9 ft. 9 in. ..... 116. 3. 14 ..... 16/6 61 7 2
33 ... 8 ... 12 in. 9 ft. ..... 266. 3. 22 ..... 140 2 11
650. 1. 8
✓ 372 19 1
Int. paid pr Wm Buckley

FIG. 2.—DESPATCH ENTRIES IN NEWTON CHAMBERS' DAYBOOK OF 1816 REFERRING TO RETORTS FOR WESTMINSTER GAS LIGHT & COKE COMPANY.

Fig. 6 is a cast-iron pattern for a retort mouthpiece which is still in use to-day. Fig. 7 shows the moulding box in which the casting is made.

The retort, which nowadays must withstand very high temperatures, is no longer made of cast iron, and the mouthpiece is, as it were, an external extension to a silica brick retort. The metal of which these mouthpieces are made is now varied to suit operating circumstances, and explanation will follow later.

All castings are made in green sand, and the point of the three openings in the moulding box and apparently only one branch on the pattern is that the branch takes up different positions, and the box is meant to accommodate them all, so avoiding a great variety of boxes; plates cover the apertures not in use. The core barrel and strickle (A) is to make the core for the socket branch. It is guided in and located by pins which screw in the box side.

Figs. 8, 9 and 10 are of an arch pipe also used on this horizontal type of gas retort, and from a foundry point of view illustrate the use of a shell pattern, a fabricated core iron, and a green-sand core. Further applications of these principles with added details also fit in later,

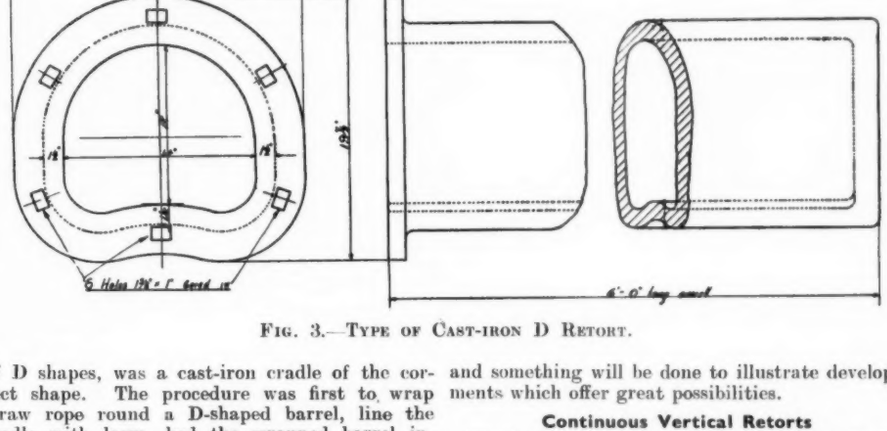


FIG. 3.—TYPE OF CAST-IRON D RETORT.

and something will be done to illustrate developments which offer great possibilities.

Continuous Vertical Retorts

High-temperature carbonisation is the backbone of the gas industry to-day, and the vertical retort is its essential medium in England.

FIG. 4.—MOULDING BOX FOR D RETORT.

Typical of this is the Woodall-Duckham continuous vertical retort, which is made in three sizes.

The retort proper is built of silica bricks, but both top and bottom are of cast iron, and are

D

in the nature of special-service castings, as there is heat, abrasion by coke, and corrosion due to acid attack, and the metallurgically-involved question of corrosion at elevated temperatures.

Fig. 11 shows the bottom ironwork across the major axis of the retort.

Consideration of the fact that newly-made coke falls directly from the retort through the extractor to the hoppers, there to await discharge, will give some indication of the complex conditions this cast-iron section must withstand. A complete description of moulding methods, equipment, sand control and metallurgical considerations would extend beyond the possibilities of this Paper. The author proposes to deal only with isolated examples which may hold interest for the expert as well as that general fraternity of foundrymen to whom particularly this Paper is addressed.

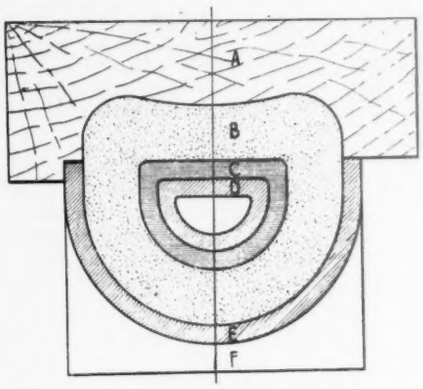


Fig. 5.—Cast-iron Core Box for D Retort Cores.

A.—Wood strickle for top shape. B.—Loam. C.—Straw ropes round core barrel. D.—Core barrel. E.—Cast-iron cradle core box. F.—Feet on core box.

Moulding Methods

Figs. 12 to 17 illustrate the manufacturing methods employed on certain bottom ironwork castings. The illustrations are self-explanatory, and call for no special comment. The principle is to avoid cores as far as possible, and all castings are made in green sand. In the case of Fig. 12 the pattern, which is of cast iron, is lifted with the outside of the mould, and is, so to speak, later drawn downwards. Quantities are insufficient to warrant elaborate quantity-production methods, as the demand is recurring rather than continuous, but much has been done in the way of shaped moulding boxes, special turning-over boards, suitable sand, and a helpful foundry layout to improve the efficiency of production.

Fig. 6.—Iron Pattern for D Retort Mouthpiece.

Many of the castings in a retort do lend themselves to more mechanised production methods, and a foundry section exists where cope parts are rammed by Sandslinger, and drag parts on a 10 ft. by 6 ft. jolt ram turnover machine. In addition there is a range of work which is rammed entirely by Sandslinger and handled on a conveyor system.

Fig. 18 gives one example of top ironwork for these continuous vertical retorts, and Figs. 19 to 25 are of individual castings, and the production equipment and method which go with them. Again, all castings are in green sand both for mould and core. It should be said that individual castings range in weight from 1½ to 12 cwts., and that the moulding box shown in Fig. 21 is some 8 ft. long, 4 ft. wide and, when complete, 3 ft. deep.

It will be observed that sometimes the structural unit is cast in one piece and sometimes in sections, and later assembled. This is because of operating conditions as well as manufacturing considerations. The illustrations cover both types.

The making of green-sand cores is a practice in which much experiment is yet to be done. The cheapness of the method on production of this kind is undeniable and obvious, but the greatest difficulty is to achieve satisfactory results without a long apprenticeship by the moulders concerned on this type of work.

Nor is it just a question of economics. Cooling rates are important, and once a composition has been established, a green mould with a dry core may, metallurgically, carry a handicap. In the production sphere the essential need in green-sand core practice is a suitably-designed, adequately-fitted core iron. Both here and in later illustrations it will be observed that the core-iron sections are prevented by tie-pieces from twisting, and bound together as a whole by screwed bars.

In this particular foundry the cores are made whenever possible alongside the mould, and, after casting, the core iron is taken out by liberating the various sections, and later reassembled for further use.

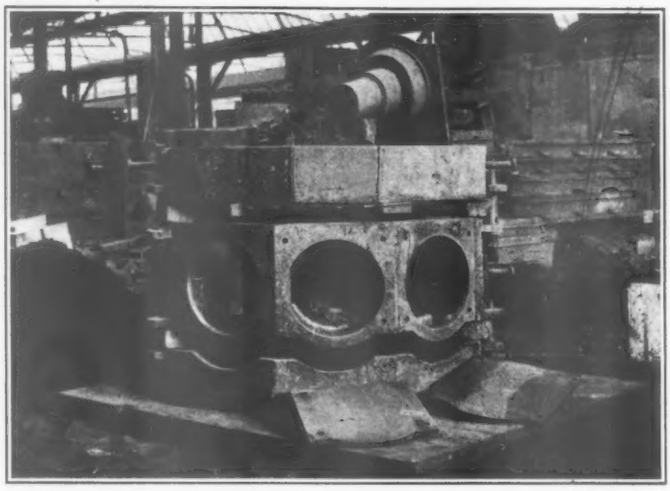


Fig. 7.—Moulding Box for D Retort Mouthpiece.

Coke-Oven Castings

Coke-oven reversing valves illustrate still better a phase of gas-plant production in green-sand mould and core. Special provision has to be made in the core box because the core is to be made green. Fig. 26 illustrates this clearly, the difference being that the insides of the core box are fitted as loose pieces. Usually no special provision is necessary.

Fig. 8.—Arch Pipe for Horizontal Retort.

Fig. 9.—Drag Part for Arch Pipe, with Pattern and Core Iron.

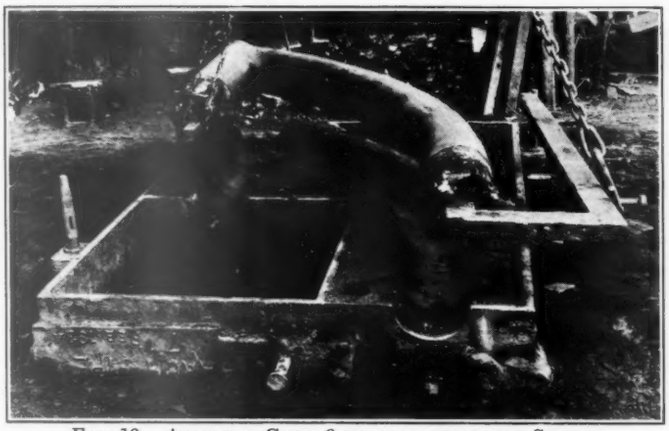


Fig. 10.—Arch-pipe Core, 6 in. dia., ready for Setting.

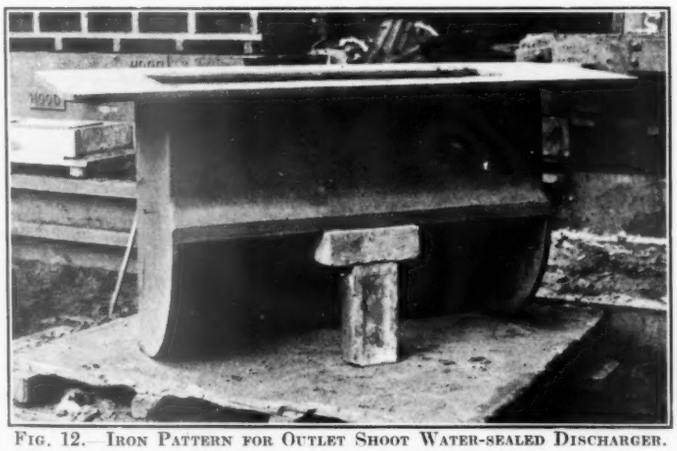


Fig. 12.—Iron Pattern for Outlet Shoot Water-sealed Discharger.

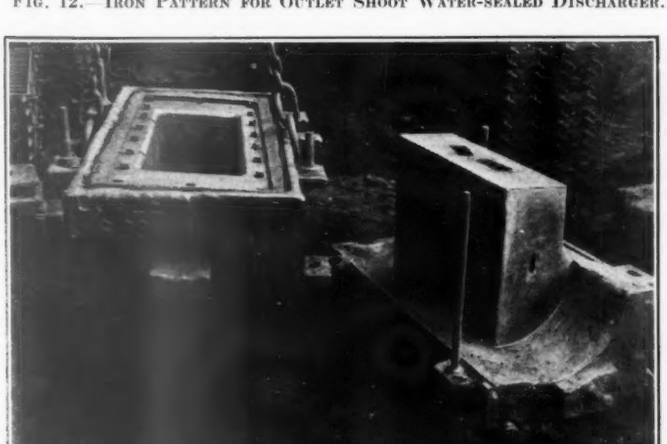


Fig. 13.—Drag and Middle Part of the Mould for Outlet Shoot.

Fig. 14.—Pattern for Top Plate of Discharger.

Fig. 15.—Three-part Mould for Top Plate of Discharger.

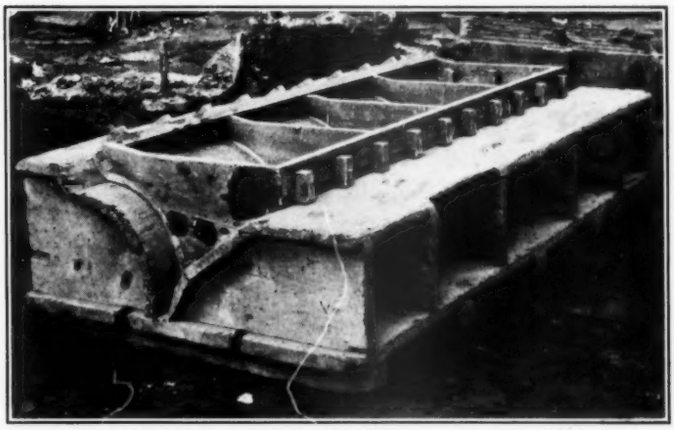


Fig. 16.—Front-Plate Pattern of Extractor Box on Turnover.

Fig. 17.—Mould for Extractor Front Casting.

Fig. 19.—Drag Part of Mould for Hopper Foot.

Fig. 23.—Mould for Hopper-foot End-plate.

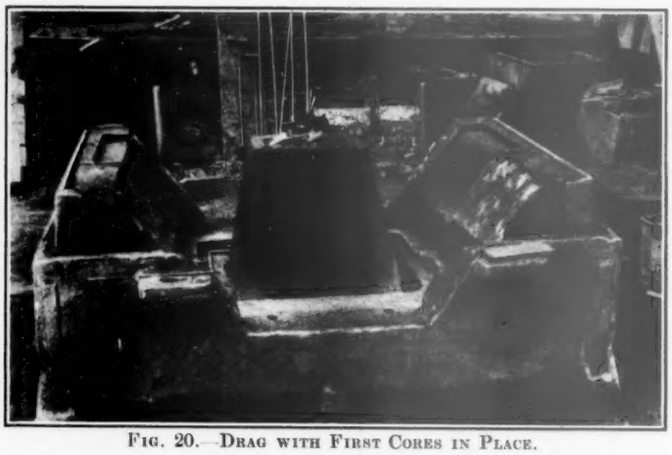


Fig. 20.—Drag with First Cores in Place.

Fig. 24.—Drag Part for Gas-offtake Casting.

Fig. 21.—Hopper-foot Mould Ready for Closing.

Fig. 25.—Cope Part for Gas-offtake Casting.

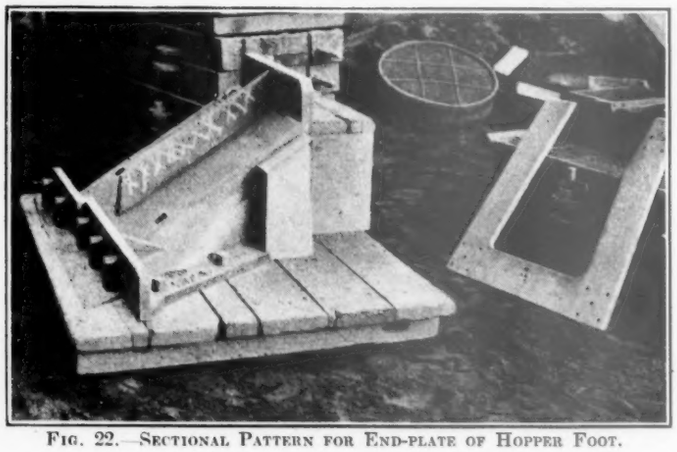


Fig. 22.—Sectional Pattern for End-plate of Hopper Foot.

Fig. 26.—Core Box and Fabricated Core Iron for Valve Body.

The particular reason here can best be seen by reference to the mode of making these cores. The procedure is to line the bottom half of the core box with sand (about ¾ in.), bed in the core iron and ram sand up to the joint of the

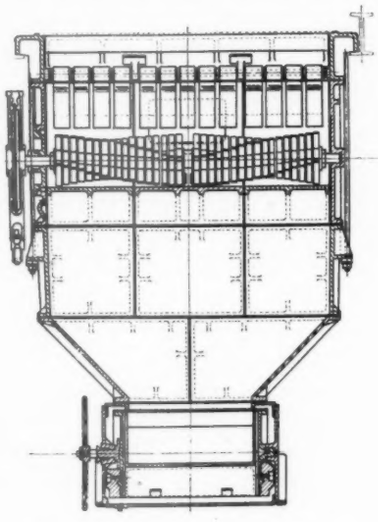


Fig. 11.—Bottom Ironwork of Retort.

box. The bottom-half is then vented by a thin wire, bars are put on to act as a centre vent, and the top half of the box is placed in position. Sand is rammed in from the open end of the box until the whole is firmly packed. The top-half of the box is taken off, the loose sides in the bottom-half of the core box are drawn out, and then the core is ready to be lifted away, and, after finishing and sleeking, put into the mould.

Table I.—*Chemical Analysis of New Sand.*
Ref. 1,710 deg. C. Sinter 1,340 deg. C.

	Dried sand as received.	Clay substance.
	Per cent.	Per cent.
Loss on ignition	2.00	12.71
Silica	80.92	36.54
Iron oxide	1.57	10.28
Alumina and titanic oxide	6.87	31.02
Lime	0.40	1.00
Magnesia	—	—
Alkali oxides	2.76	3.48

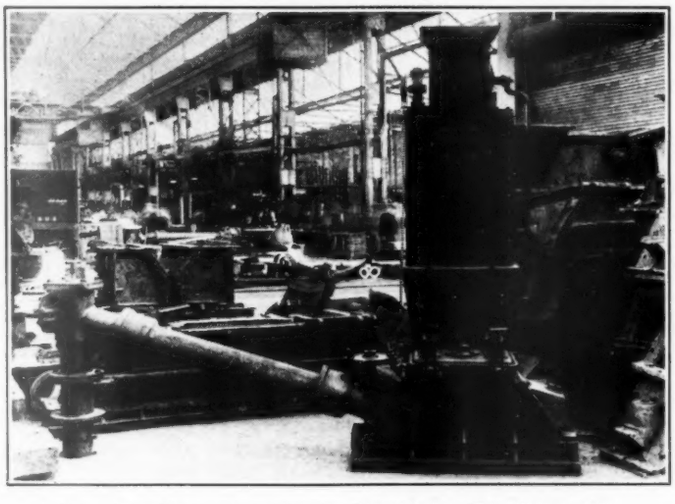


Fig. 18.—Part Assembly of Small-type Top Ironwork.

The extensions on the core irons serve as lifting bars, and also as a means of holding down the core. No studs or chaplets are necessary. There is a core iron in the bottom-half of the core only. Whenever possible, these larger green-sand cores are allowed to air-dry overnight before use. Usually the moulder makes core as well as mould, and part of the provision for this type of moulding is properly shaped moulding boxes into which the core irons can fit and be held in position.

The arbour portion of the core iron always carries a larger bar which fits accurately into a place in the moulding box left specially for it. The construction adopted allows a single core iron to be used hundreds or even thousands of times. Sand for the cores is of the same composition as that for moulds.

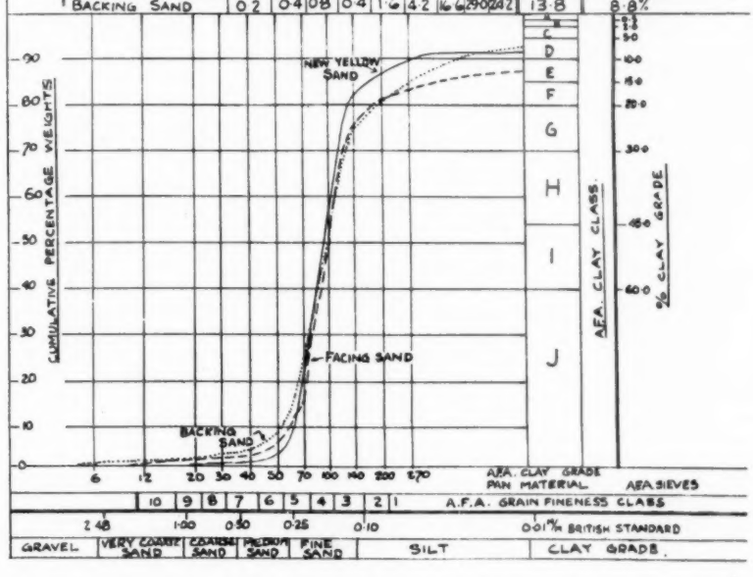
Sand Data

Throughout this foundry none of the sand for green-sand work is milled. A naturally-bonded sand is used, and mixing is effected either by hand or by putting the sand through a pin-type disintegrator. Coal-dust of superfine grade (passed through 200 mesh) is used to the extent of about 10 per cent., and the proportion of new sand varies from 5 to 30 per cent. according to type of casting.

Table II.—*Properties of New, Facing and Backing Sand.*

No.	Moisture %	Density g/cc	GREEN A.F.A. Permeability	GREEN lbs per sq. inch Crush	GREEN lbs per sq. inch Shear	DRY Temp. C°	DRY A.F.A. Permeability	DRY lbs per sq. inch Crush	DRY lbs per sq. inch Shear	
New	7·5	1·65	40	2·75	-	200 400	- -	96 127	- -	Milled for 6 mins in 15 lbs Simpson Mixer. Rather wet
Facing	6·6	1·50	26	6·7	-	200 400	- -	32 Friable	- -	Tested as received
Backing	5·0	1·47	55	4·4	-	200 400	- -	Friable Friable	- -	Tested as received

A.F.A. Washing & Grading Test	on 6	12	20	30	40	50	70	100	140	Silt through 140	Clay Grade by A.F.A. Method
New Yellow Sand	-	-	0·1	0·1	0·2	2·2	18·4	36·0	26·2	7·6	9·2%
Facing Sand	0·2	0·4	0·6	0·2	0·6	2·0	14·0	32·2	26·8	9·2	13·8%
Backing Sand	0·2	0·4	0·8	0·4	1·6	4·2	16·6	29·0	24·2	13·8	8·8%



Tables I and II cover the general properties of new, facing and backing sand. This sand is used throughout the system, for hand moulding, jolt-ram machine, Sandslinger, and squeeze machine. It leaves a good face on the castings even with rapid production methods.

Castings are not sand-blasted because it is desired to retain the original skin, and the elimination of sand-blasting means that some types of synthetic sand cannot be used. Moulds are dusted with plumbago and sleeked.

(To be continued.)

Shop-Lighting Obscuration

The Metropolitan-Vickers Electrical Company, Limited, of Trafford Park, Manchester, 17, have developed a system of shop lighting associated with complete protection against light emission through windows. This has been effected by utilising monochromatic electric discharge lamps for the interior lighting, whilst to prevent the exit of light, use is made of a lacquer applied to all the windows. This lacquer has been so compounded that it allows the maximum amount of daylight to enter, but absorbs the artificial shop light. By this means a great contribution has been made in the obscuration of factories during war-time, and congratulations are due to those responsible for the development. A pamphlet covering the innovation has been prepared, and is obtainable from Trafford Park.

Application and Finishing of Antimonial Lead Castings*

By NATHANIEL HALL, Ch.E.

Antimonial lead castings serve a field of application intermediate between that of high-temperature sand or chilled mould castings such as brass, bronze, iron, etc., and zinc, aluminium or magnesium base die-castings. A comparison of the advantages and limitations of these three types of casting methods will illustrate to best advantage the part that lead casting plays in industry.

High-melting or hard metal castings are employed where strength and resistance to temperature, corrosion and abrasion are desired. This type of casting requires many finishing operations for the production of a good lustre. Accurate dimensions are not possible and machining is often necessary when the casting is used in an assembly. However, the cost of the mould is very low and heavy castings weighing many tons can be produced.

Die-casting opened a new field in the mass-production of parts to fairly exact dimension which were interchangeable, and the surface condition of which was such as to require very little polishing. The moulds are expensive and the process is therefore usually limited to applications where machining operations are to be kept at a minimum, and light weight together with strength are desired. Due to the labour and expense of operating the casting machine, the process is not suitable for runs of less than a few hundred at one time, although one automobile manufacturer found it more economical to make a die for a total production of only two hundred special windscreen frames than to make them any other way.

Ornamental novelties such as book-ends, trophies, statuettes, souvenirs and similar products are not required to meet any specification as to strength, interchangeability, or resistance. What is required is a cheap casting which can easily be soldered, does not require much polishing to produce a highly polished surface, and which can be made economically singly or in quantities without the use of an expensive mould. Antimonial lead or slush-mould casting is the answer to these requirements.

Slush-Moulding Technique

Casting is done by hand, the molten alloy being ladled from a gas-fired pot. When the mould is filled, the excess metal is poured back into the ladle and returned to the pot. One of the requirements of an experienced caster is the ability to time this operation so that a sound, hollow casting is produced with a minimum thickness of wall. In order to maintain uniformity in weight and thus avoid waste of metal, occasional castings are weighed. While pouring, the mould may be supported by rods which extend from sections of the mould and allow the caster to pivot the mould when draining the excess metal, thus lessening fatigue.

After the excess alloy has been poured out, the mould is immersed in a tank of water to chill the casting. The pins which hold the sections of the mould together are removed and the mould is opened, using a mallet when necessary on large and complicated shapes. A study of the casting procedure shows that even a single casting can be produced almost as economically as a number of castings, so that quantity production is not necessary to keep the cost down and large stocks of the various items need not be maintained.

The moulds are made of bronze. When a run is completed the last casting is left in the mould to keep the parts together. The casting alloy is the lead-antimony eutectic containing from 12 to 13 per cent. antimony and melting at about 250 deg. C. Antimony is used to strengthen the casting and also causes the alloy to flow freely into all corners of the mould. The casting pots are hooded and the metal fumes are exhausted.

The gates are removed from the castings by a metal saw and the fins and sprues are filed off by hand at filing benches, after which the parts are sent to the soldering department. Here various parts are attached to the castings, such as threaded rods for fastening to the bases. Castings which would be difficult and expensive to produce in one piece are made in sections which are assembled using a soldering torch supplied with gas and compressed air. When the soldering operations are completed, each lot in its individual box or tray is sent to the finishing department.

Surface Preparation of Castings

For polishing lead castings a well-lighted polishing room is very desirable, even more so than for polishing other metals because of the variety of models and contours. Because of the softness of the metal and the appreciable weight, only one layer of castings is placed in a box where quality work is desired, such as in the production of statuary or trophies.

In most cases, the first finishing operation is the cutting-down with tripoli on a full disc loose buff. On certain classes of work, this is preceded by a brushing on a tampico wheel with emery cake. With moulds in good condition and proper preparation at the filing benches, polishing with a set-up wheel is rarely necessary and often the only operation is colouring with silica compound, lime compound or a pink lime containing crocus. Castings to be satin finished are buffed with a greaseless compound.

Plating of Castings

The polished castings are racked or wired, degreased and are then cleaned cathodically at six volts in a solution containing 2 ozs. per gall. each of soda ash and trisodium phosphate or a proprietary mild cleaner at about 85 deg. C. for approximately ½ min. After thorough rinsing, the work is immersed in a solution containing 25 per cent. by volume of hydrochloric acid for about 5 secs. and again rinsed. The acid film is neutralised by an immersion in a solution consisting of 4 ozs. per gall. of sodium cyanide, after which the work is plated for the required finish, which may be gold, silver, copper, brass, nickel or chromium.

Various procedures are used here, depending on the finish and the use to which the article is to be put. Thus at the plant of Maisto's, Inc., Brooklyn, N.Y., more than 150 different styles of pepper and salt shakers are produced in various finishes. Castings to be finished in silver are flashed in a standard brass solution, nickel-plated for 10 min., and after rinsing are transferred to a standard silver strike containing 0.4 oz. per gall. (troy) of silver and 8 ozs. per gall. of free cyanide. After a 30-sec. strike, the articles are silver-plated with various thicknesses of silver. Because of the unusually high drag-out losses encountered when plating these hollow shaker bodies, the metal content of the plating solution is held down to 1.5 tr. ozs. per gall. of metallic silver with a free cyanide content of 3 ozs. per gall. of sodium cyanide. Shakers to be chromium-plated are nickel-plated in a normal cold nickel solution for ½ hr. and buffed. They are then re-racked and chromium-plated for 1.5 min. in a 53-oz. solution at 95 deg. Fah. and 100 amps. per sq. ft., maintaining a chromic acid sulphate ratio of 100:1. In buffing the nickel deposits, care must be taken to avoid heating the castings, since the lead softens and the deposits will then blister. Heavy chromium deposits must also be avoided to minimise cracking of the deposits as a result of the high stresses set up.

At the Crescent Art Novelties Company, in Newark, N.J., where metal novelties, lamps, ash trays, trophies and statuary work in antimony lead are manufactured for the better quality trade, articles to be chromium-plated are given a copper deposit of at least 0.0003 in. thickness which is buffed or satin finished. After cleaning, a heavy nickel deposit is applied, the articles are buffed and chromium-plated. At this same plant, all work to be finished in silver is given a 10-min. nickel deposit, and, after rinsing, is transferred to the silver strike and plated in a regular silver solution containing 2.5 tr. ozs. per gall. of metal and 3.5 ozs. per gall. of free sodium cyanide.

The less expensive line of novelties is finished in oxidised brass or copper and relieved on rag wheels using lime compound or a soft silica for bright highlights and greaseless compound for the satin finish highlights. They are then sent to the lacquering department, where they are sprayed with clear, air-drying lacquer.

Castings which are used for bases may be sprayed with two coats of non-gloss black or gunmetal lacquer or any enamel colour and air-dried. The finished figures and bases are assembled in a well-lighted section of the building. They are given a final thorough inspection for possible defects and are then packed for despatch. Onyx and solid walnut bases, when used, are purchased finished and are drilled in the assembling department for mounting of the figures.

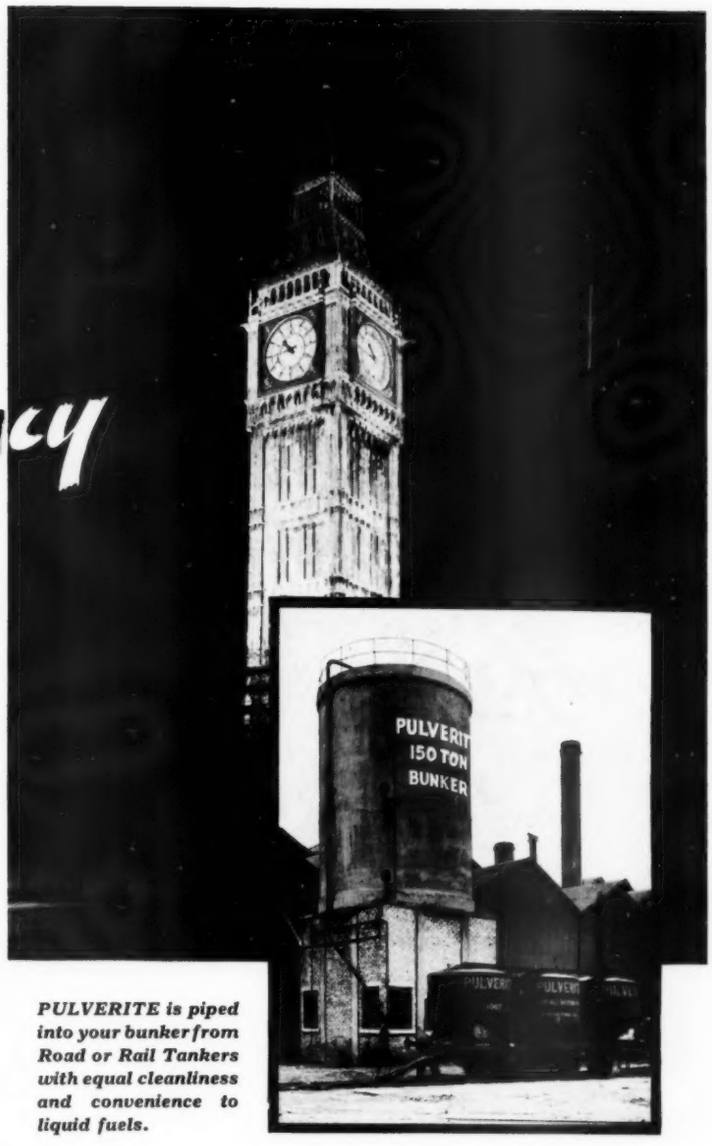
In the manufacture of trophies, the engraving is applied to the base after plating, since, if applied first, the engraving would be covered by the deposits which cannot be polished satisfactorily deep down in the cuts and would consequently remain dull instead of bright. Perfect adherence of the deposit is essential to avoid peeling when the engraving tool is applied. When the deposits peel, the engraved trophy bases must be stripped and replated, but other articles which are defective are thrown into the lead pot, where the deposited metals float to the top and are skimmed off with the dross.

The antimonial-lead castings are not the only type which fill the requirements intermediate between the hard casting and the die-casting. It shares this field with the zinc-aluminium casting which is sometimes known as unbreakable metal. This latter metal is too brittle to be joined by peening over projecting lugs as is often done with lead. It is predominant, however, in the lamp industry, where it has almost completely displaced iron castings cast in sand for lamp bases, columns, finials, etc., because of the better surface which is more economical to finish. Lead is rarely used for this purpose, because of the softness and comparative lack of strength.

* Extract from "Metal Industry" (New York).

Building Industry

The position of the building industry shows an improvement in most areas compared with recent months. The number of building operatives unemployed in April, at 142,288, showed a reduction of some 17,000 compared with the previous month and of nearly 100,000 since January. Nevertheless, there are still 18,600 more building operatives unemployed than a year ago, and the rate of unemployment at 13.5 per cent. of the insured building operatives is the highest for April since 1935. The value of buildings for which plans were passed during March by 142 urban authorities outside London, at £9,240,000, showed an increase on the year of £711,000, or 8.3 per cent. The increase was mainly in the northern part of the country, particularly in Scotland and Yorkshire. Heavy falls were recorded in the South. The largest increases among the categories were in factories, where the rise was mainly in Yorkshire, and schools and public buildings, mainly in Wales. The position of public works contracting also shows an improvement.



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The Art of Moulding*

By J. C. HALLAMORE

In this age of repetition work, time and motion study, and the like, the lot of the jobbing ironfounder who is not in the position to set up special tackle and boxes, or is not handling orders with a sufficient number off to warrant the expense, may easily be overlooked and individual craftsmanship eclipsed. He must be prepared to adapt patterns to existing tackle and boxes, which means that the castings may not be produced by a possible quicker method. With this view in mind, the author presents the following castings produced in a jobbing foundry.

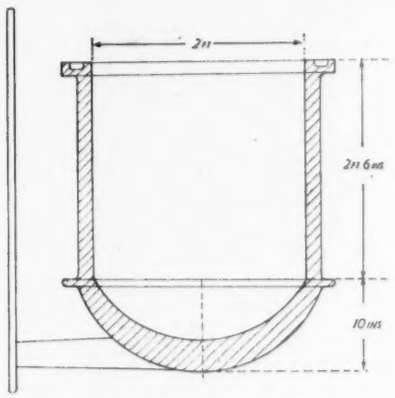

FIG. 1.—ACID POT WEIGHING 10 CWTS.

The first example is an acid pot weighing 10 cwts. (see Fig. 1), which presented no difficulty in moulding, yet the tackle used may be of interest. A complete pattern was made, split at the dome and bottom flange, with a core box for the dome and a ring box for the body 8½ in. deep—four cores making the full depth.

***Method of Moulding.*—The dome was first placed on a board, the bottom box was rammed up and then rolled over. The flange was placed on, the bottom joint made, and lastly the body pattern put in position. The middle boxes, three in number, were put on as ramming up proceeded, the top joint made and the top box rammed up. The lifting of boxes and the finishing of the mould proceeded by usual methods. The method of running is shown in Fig. 1. The in-gate was 2 in. by ¾ in., with a 1-in. dia. down-gate. Both the bottom and middle parts of the mould were dried in the stove.**

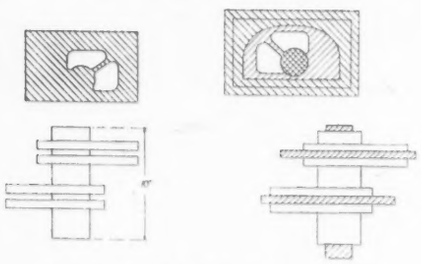

FIG. 2.—CORE BOX AND PATTERN FOR LOOM CAM.

***Making the Core.*—A grid with two lifting hooks was bedded in the dome core box and the first ring-core for the body was rammed up as part of this bottom core, the other three being made separately, each having a plain ring grid bedded in.**

***Closing the Mould.*—The complete mould was lowered into a pit to facilitate access. After thickness strips had been placed on the bottom, the core was assembled and lowered into the mould, side thickness strips being used, keeping the core central. The top box was then lowered on, and the core bolted to the top. The box and the core were lifted off and any damage to either repaired, after which the mould was closed for pouring. The mould and core were produced in 12 hrs.**

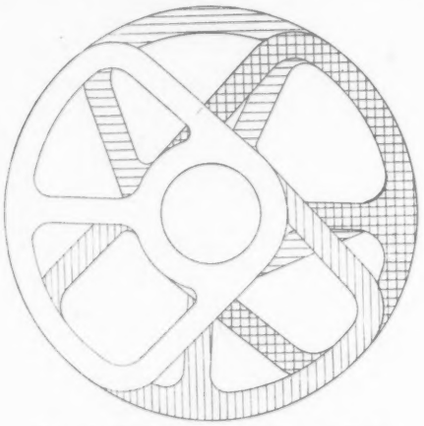

FIG. 3.—FOUR-ARMED LOOM FOR CAM.

A Textile-Machinery Casting

The next example, shown in Figs. 2 and 3, is a four-armed cam for a loom; the weight is only 16 lbs. The pattern (lower right sketch, Fig. 2) was split at the centre for a three-part job, with a core box to form the arms and produce a left-hand and right-hand core. The top and bottom of the core box (upper sketches, Fig. 2) were worked loose.

***Method of Moulding.*—The bottom half-pattern was rammed up and rolled over; the middle and top half of the pattern being added the middle was then rammed up. The top box being in position, the mould was finished by usual methods. The two arms on the top of each core print were worked loose for ease of lifting. The casting was run in the bottom arm with a riser on the boss. The mould and core were produced in 30 min.**

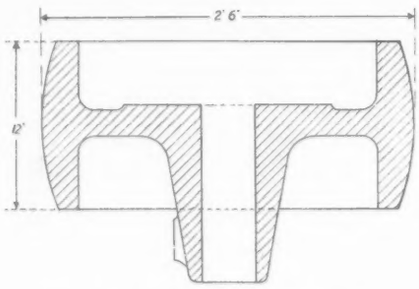

FIG. 4.—SKID WHEEL FOR PLOUGH.

A Loam Moulding Job

This Paper would not be complete without reference to strickle work, a method very often adopted by the jobbing ironfounder. The example selected is a skid wheel for a plough weighing 4 cwts. (Fig. 4). Two strickle boards, a loose boss and facing were all the pattern work required. These are shown in Fig. 5.

***Method of Moulding.*—The bottom and middle boxes having been set and the spindle centred, the first strickle for forming the top cod was secured on the spindle arm and the mould struck up. The spindle was then withdrawn and the facing centred; the top box was placed on and the cod liftered and rammed up. The top box was then removed and the sand dug out; the spindle was replaced and the bottom strickle secured on to the spindle arm. The centre boss having been previously bedded round the spindle, the mould was rough-strickled, vented and sprigged, and finished by the usual method.**

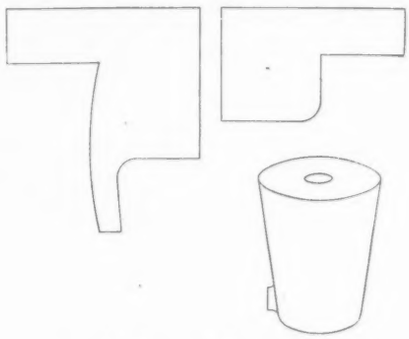

FIG. 5.—PATTERN EQUIPMENT FOR SKID WHEEL.

The mould was run on the centre boss and with two risers off the rim. The time for moulding was 7 hrs.

* Short Paper presented to the East Midlands Branch of the Institute of British Foundrymen.

Parliamentary Notes

Imported Steel Castings

MR. ELLIS SMITH asked the President of the Board of Trade whether he was aware that shipbuilding firms carrying out Government contracts and proposed subsidised shipbuilding had obtained and were obtaining the required steel castings from abroad.

MR. STANLEY replied that he would be glad to consider any instances which were brought to his attention where foreign castings were being used in the construction of merchant ships when British castings were available at competitive prices. Admiralty shipbuilding contracts required the steel castings used to be of British manufacture.

Asked if he was considering the advisability of issuing a regulation that, where shipbuilding contracts were subsidised, the material and castings should be ordered in Britain or in the Colonies, MR. STANLEY replied in the negative. He said he had to take into consideration the questions of time and availability, because it was his desire to get ships as quickly as possible, but he had expressed the hope that wherever possible British material would be used, and he had received an assurance on the point.

Cast-iron Baths from Germany

MR. ADAMSON asked the President of the Board of Trade whether his attention had been drawn to the fact that large numbers of baths, equal to 25 per cent. of the British requirements, were being imported into this country from Germany, and that the German Government provided a very heavy subsidy for this purpose; and as short time was being worked in the industry in this country, and workpeople had been threatened with discharge because of these subsidised imports, if he would take powers to regulate their import by the imposition of a quota.

MR. STANLEY: Imports of baths into this country are governed by an international agreement among industries. In recent months, imports from Germany have exceeded the agreed limit; but I am informed that steps are being taken, by agreement between the British and German industries, to correct the position. I have no information regarding any subsidy to German exports. Cast-iron baths imported into this country at present pay a duty of 15 per cent. *ad valorem*.

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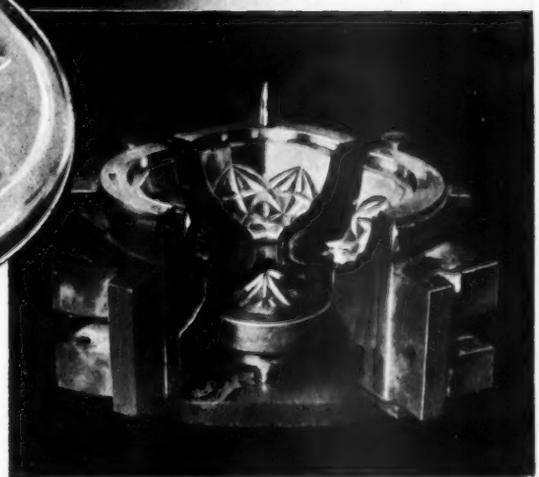

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The Week's News in Brief

Trade Talk

A PARTY of members of the Manchester Association of Engineers paid a visit to the works of David Brown & Sons (Hudd.), Limited, Huddersfield, last Saturday.

HARLAND & WOLFF, LIMITED, of Belfast, have received an order from the Royal Mail Lines, Limited, for the construction of four cargo vessels for their South American service.

PLANS FOR extensive alterations to their engineering department were submitted by Carron Company, Falkirk, at a sitting of Falkirk Dean of Guild Court. The scheme will cost about £3,700.

PLANS SUBMITTED by Head, Wrightson Stampings, Limited, Thornaby-on-Tees, for their new factory at Seaton, near West Hartlepool, have been passed by the Stockton Rural Council. The site lay-out provides for works buildings 250 ft. in length and 66½ ft. wide, superficial floor area of the factory being 16,500 sq. ft. Plans were also approved for offices, power and meter houses, workmen's welfare facilities, etc., with floor area of 4,220 sq. ft. The company, which is to specialise in the production of aircraft and automobile components, is expected to commence production in August.

THE TOTAL NUMBER of completed factories on the Team Valley Trading Estate at the end of last month was 105, of which 97 were occupied and 95 in production, employing 2,603 people. Six further factories were under construction. On the detached sites at Pallion, St. Helen Auckland and Tynemouth, there were seven factories completed and occupied, two under construction, and 442 persons employed. On the South Wales Trading Estate at Treforest at the end of April, the total number of completed factories was 54, of which 43 were occupied, giving employment to 1,518 people. A further 13 factories were under construction. On the detached sites at Cyfarthfa, Cwmbran, Dowlais, Llantarnam, Porth and Ynyswen, the position at the end of April was as follows:—Factories completed and occupied, 7; factories under construction, 1; persons employed in factories, 1,525. In West Cumberland, five factories were occupied at the end of last month. Another factory was completed at Maryport. Two tenants were in occupation of the greater part of the reconstructed Cleator Mill, one was in occupation at Maryport, one at Hensingham, and one at Millom.

Personal

MR. C. R. F. ENGELBACH has joined the board of Birmid Industries, Limited.

PROF. W. L. BRAGG has been elected President of the Institute of Physics.

MR. ALFRED CLEMENTS, assistant secretary of the British Thomson-Houston Company, Limited, has completed 50 years' service with the company.

SIR HAROLD CARPENTER, F.R.S., has been elected chairman of the Joint Committee on Materials and Their Testing, in succession to Dr. H. J. Gough, F.R.S.

MR. A. BOYES, of 377, Liverpool Road, Patricroft, Manchester, has been appointed hon. secretary (*pro tem*) of the Lancashire Branch of the Institute of British Foundrymen. Arrangements for the reception of visitors in Manchester during the Post-Congress Tour will be carried through by Mr. J. E. Cooke.

MR. J. R. RICHMOND, senior director of G. & J. Weir, Limited, engineers, Holm Foundry, Cathcart, Glasgow, received a presentation from the directors, staff, and employees on Tuesday, May 16, to mark his completion of 50 years' service with the firm. Mr. Richmond, who is a governor of the Royal Technical College, Glasgow, commenced his career with the firm as an apprentice patternmaker.

MR. ARTHUR H. WOLSELEY, managing director of Charles Clifford & Son, Limited, received a presentation at a dinner held in his honour in Birmingham in commemoration of his 60th year in the non-ferrous metal industry. The presentation was made on behalf of the Brass and Copper Tube Association, the Brass Wire Association, the Brazed Brass Tube Association, the Cold Rolled Brass and Copper Association, and the individual members of these associations. Mr. Wolseley, during his 60 years in the non-ferrous trade, has taken an active and leading part in the industry, and was chairman of the Brass and Copper Tube Association—one of the oldest trade associations in the country—for eight years, chairman of the Brazed Brass Tube Association for five years, and chairman of the Cold Rolled Brass and Copper Association for three years. Mr. Wolseley is still an active member of the executive committees of a number of trade associations, and is vice-chairman of the British Non-Ferrous Metals Research Association.

Will

SMITH, SIR LOUIS W., M.P. for the Hallam Division of Sheffield, chairman of Clarke's Crank & Forge Company, Limited, Lincoln; Farrar Boiler Works, Limited, Newark-on-Trent, and Ambrose Shardlow & Company, Limited, Sheffield, and a director of other companies £96,155

Obituary

THE DEATH has occurred of Mr. C. E. Crompton, chairman of Cochran & Company (Annan), Limited, Annan, at the age of 63.

MR. FRANK WIGGLESWORTH, founder of the firm of F. Wigglesworth & Company, Limited, engineers and ironfounders, Clutch Works, Shipley, has died.

MR. ROBERT BINNIE, who died last week, aged 71, retired about 18 months ago after 50 years' service as a moulder with Dobbie, Forbes & Company, Limited, at Larbert.

MR. PETER AINSLIE JACKSON, manager of the melting shop of Taylor Bros. & Company, Limited, Trafford Park Steelworks, Manchester, has died in his 56th year.

MR. HUGH RICHARDS, manager of the sheet and strip sales department of the American Rolling Mill Company, died recently. Mr. Richards, who was 49 years old, was a native of Penarth, South Wales.

MR. MENCE WILKINSON died recently at his residence at Great Bookham, Surrey, at the age of 75. He was chairman of the Central Provinces Manganese Ore Company, Limited, and the United Kingdom Ferro-Manganese Company, Limited.

SIR HERBERT RAYMOND DENNIS, co-founder and joint managing director of Dennis Bros., Limited, of Guildford, died on Saturday last, at the age of 60. He played an important part during the Great War in the supply of motor-lorries and fire engines to the Government. He was awarded the K.B.E. in 1920.

MR. J. BUCKLER M'TURK, who died in Sheffield recently at the age of 68, was well-known in ironfounding circles throughout the country, having been for 25 years managing director of the Dorrator Iron Company, Limited, Falkirk. He retired in 1935, but remained a member of the board. He went to take up residence at Sheffield.

MR. WYBERT FIRTH, works manager for the Consett Iron Company, Limited, died on May 17, aged 58. Born at Rotherham, he served his time as an engineer in the Midlands. He gained further experience during a stay of two years at Pittsburgh, Pennsylvania, and then took up a post at Wellington, Shropshire. He remained there for five years, served a similar period as an engineer at Ebbw Vale, Monmouthshire, and joined the Consett Iron Company as chief engineer in 1917. Three years later he was made works manager. The big reconstruction scheme at the works in 1926 was carried out under his direction.

Contracts Open

London, S.W., May 31.—Provision and erection of a direct-coupled multi-cylinder Diesel engine and alternator for supplying power to existing pumping plant, for the Merton and Morden Urban District Council. Mr. R. W. North, engineer, Council Offices, Kingston Road, Merton, London, S.W.19. (Fee £1, returnable.)

Winchester, June 12.—Construction and maintenance of 11 miles of cast-iron and stoneware pipe sewers from 7 in. to 15 in. dia., for the Rural District Council. Lemon & Blizard, engineers, Lansdowne House, Castle Lane, Southampton. (Deposit £5 5s., returnable.)

Company Meetings

Stewarts and Lloyds, Limited

An increased profit in spite of lower output was reported at the annual meeting of Stewarts and Lloyds, Limited, held in Glasgow on May 16. MR. A. C. MACDIARMID (chairman) said that the trading profit of £2,649,107 compared with £2,505,796 for 1937. Trade in general during 1938 was on a much lower level than in 1937. Their production of tubes fell by some 16 per cent. With a falling off in output of this order a corresponding decline in profits might have been expected. The explanation was anticipated in his speech of last year. He said that they expected to benefit progressively from the capital expended at Corby, and at their other works, and that important additions to plant which had been brought into operation during 1937 had had only a partial effect on the profits of that year. He also made it clear that the year 1937 did not receive for the full 12 months the benefit of the improved level of prices which had been established in the home and export markets. The year 1938 benefited to the full extent from the improved prices, and this, with the progressive advantages derived from their capital expenditure and other general co-ordinating activities, fully accounted for the larger profit earned on the reduced turnover. They had appropriated the sum of £500,000 out of profits and placed this to a "reserve for maintenance and development of export trade." There seemed to be a tendency to assume that this indicated a weakness in the co-operation existing between the British and foreign tubemakers. That was not the case, nor was it the point of view from which the directors regarded the matter. Their export arrangements were running smoothly and harmoniously, and they were maintaining at reasonable prices their regular share of the market. They would not, however, be acting in the interests of the company, or in line with the necessity for developing the nation's export trade, if they were to accept for their industry a permanently static position. There were some 33 countries where the manufacture of steel tubes and pipes was carried on in some form or another, and the producers in many of these countries were not, and never had been, members of any cartel. Further, there were many different classes of tubular products which they produced which could not be cartelised, and there was therefore a field for further development of products outside any likely cartel arrangements. They had also to consider the disadvantages with which they might have to compete on account of subsidisation and exchange conditions. It might be that assistance to meet this situation would be forthcoming from the Government or from organised industry in some form or other, but, whether or not, it was the directors' duty to see that the company's position was strengthened to such an extent that it could meet competition of that or any other kind with equanimity. On a question of straight cost they had no one to fear. Their production cost figures were benefiting progressively as a result of the capital expenditure of recent years. Demand was strong and increasing both in the home and export markets, and the profits earned during the first quarter of the year showed a considerable improvement on those for the corresponding period of last year.

Babcock & Wilcox, Limited

Work in hand at the beginning of 1939 constituted a record in the history of the company, said LT.-COL. J. H. M. GREENLY (chairman) at the annual meeting of Babcock & Wilcox, Limited. New business had been coming in during the first quarter of this year at the normal rate, so that there was every prospect of the works being fully occupied during the present year, provided that there were no international complications requiring the diversion of the company's activities into new channels. In 1936, said the chairman, certain trade investments were sold, realising £435,503, and as no attractive industrial investment was then offering, the money was invested in Government securities. During 1938 an opportunity arose for investing the major portion of these funds in businesses auxiliary to their own. These investments explained the increase of £421,840 in shares in subsidiary companies.

Forthcoming Event

JUNE 12-17.

International Foundry Congress and 37th Annual Conference of the Institute of British Foundrymen:—In London, with headquarters at the Dorchester Hotel, Park Lane, W.1. For full details, see F.T.J., April 13, pp. 303-4.

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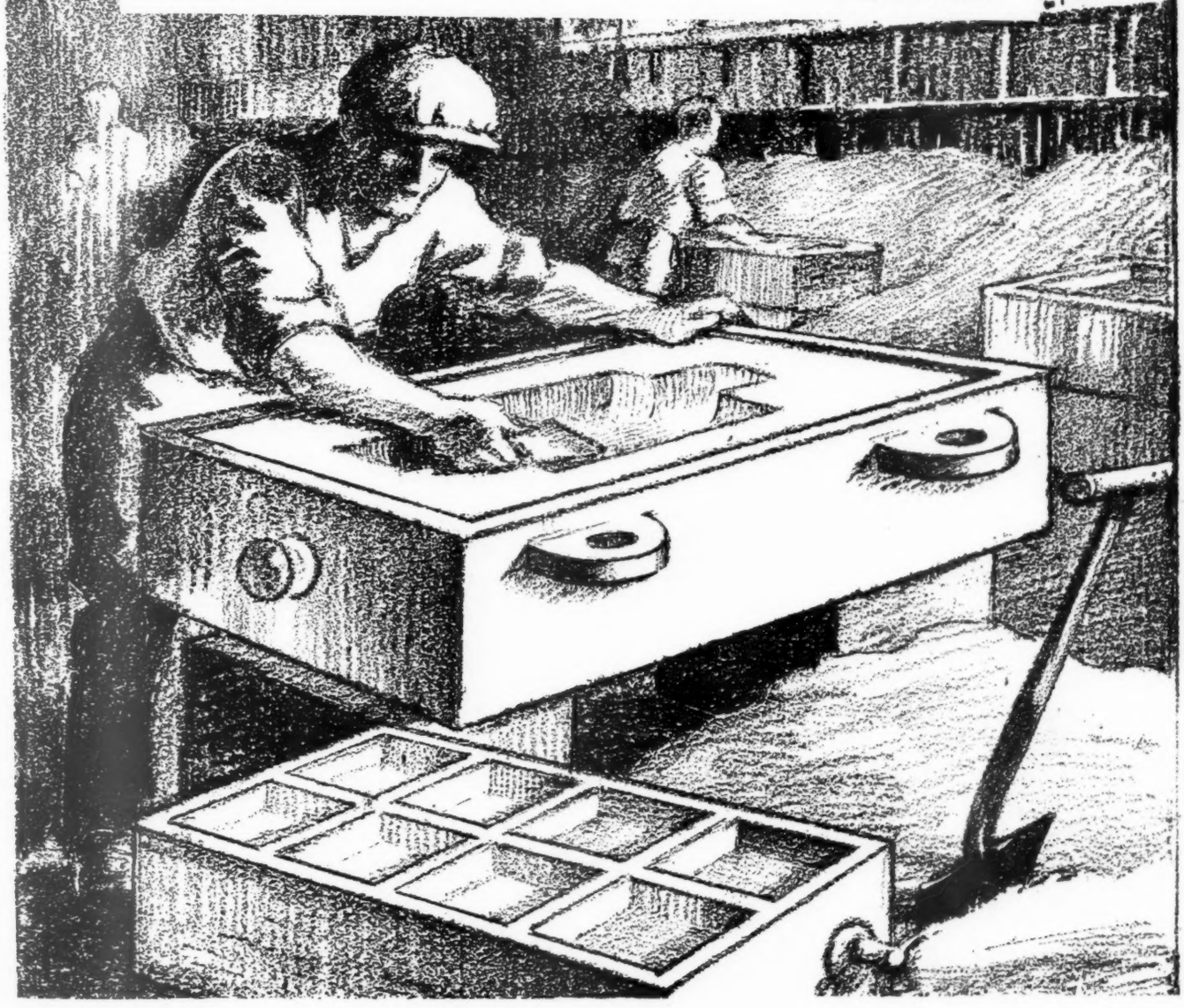

Raw Material Markets

Appreciation of the steelmakers' early decision with regard to quotations for the third quarter of the year has been expressed in all sections of industry. Foundry pig-iron prices remain unchanged, and there is no fixed period for their duration. The demand for foundry pig-iron continues to be disappointing, but other descriptions of both iron and steel are fully taken up, and producers are operating their plant to capacity.

Pig-Iron

MIDDLESBROUGH.—Despite the very slow rate at which supplies of foundry iron are being called for, it is not by any means certain that lower prices will be brought into operation when producers do revise quotations. Nevertheless, consumers are no doubt influenced by the possibility of reduced prices in their buying policy, which at the present time is restricted to early requirements. No. 3 Cleveland G.M.B. foundry iron is currently quoted at 99s. per ton for delivery in the Middlesbrough and Falkirk areas and 102s. on Clydeside, less 5s. rebate. The demand for forge iron, too, is quiet, but basic iron, at 92s. 6d. (nominal), is being consumed in large tonnages by local steelworks.

Consumers who have supplies of hematite already booked, are accepting deliveries at quite a good rate, but the announcement that prices will be reduced by 5s. per ton after the end of next month has had the effect of curtailing business very considerably. In fact, it is unlikely that much will be done for the next few weeks. Consumption is satisfactory and business should be quite brisk when lower prices are brought into operation.

LANCASHIRE.—Consumers are taking up supplies of foundry iron under contract, but not very much new business is being done. It is appreciated that prices of foundry iron are liable to be altered at any time, and, consequently, buyers will not take up further large tonnages, as they may be able to make purchases at lower prices in the near future. The quietest working-up plants at present continue to be among the jobbing foundries, light-castings makers and textile machinists. Most other consumers are fairly well placed for work. Hematite is being used quite freely in this area, but not much buying will be done until the reduced quotations come into operation at the end of next month.

MIDLANDS.—Moderate tonnages of high-phosphorus iron are changing hands, but consumption is still at a comparatively low ebb. Buyers have no information with regard to the trend of future prices and any change in quotations may well be in either direction. Activity among light-castings founders is very disappointing; this trade depends to a considerable extent upon the building industry, which should now be operating at a high rate, but the latest Ministry of Labour returns indicate that there was a decline last month of 8.5 per cent., as compared with the corresponding month of last year, and of 19.5 per cent. compared with March of this year. There is a shortage of basic iron, which is used extensively by the steelmakers, and it is possible that some local makers of high-phosphorus iron will shortly devote their production to this grade of iron. Low-phosphorus iron is still being bought in heavy tonnages by the heavy engineering concerns, which are very actively employed on Government orders. Consumption of hematite is better than it was a few months ago, but stocks at the makers' works are still rather considerable and it will be some time before the necessity arises for increased outputs. Current prices of hematite, which are 131s. for East Coast No. 3 and 132s. for West Coast material, less 5s. rebate, will be reduced by 5s. for deliveries from July 1.

SCOTLAND.—With the local shipbuilding concerns very much more active as a result of Government assistance, the tone of the market in this district is improved and foundry iron is being taken up more freely. Nevertheless, there is still a reluctance on the part of consumers to book far ahead. Especially is this the case among the light-castings makers, who continue to operate their plants well below full capacity. Large supplies of both hematite and basic irons are being melted by the steelmakers, the former being quoted at 120s. 6d. and the latter at 92s. 6d. The price of hematite after June 30 will be 115s. 6d., and this quotation will rule until the end of October.

Coke

While the demand for foundry coke for domestic use has declined somewhat of late, there has been a further improvement for export and the market is firm. Foundries are taking up quite substantial tonnages, too, and it is scarcely likely that, in the circumstances, producers will reduce the existing minimum price of 50s. 6d. for both Durham and Welsh coke when the question is considered at the end of next month. Another factor which will probably influence makers to maintain the present price is the heavy demand from the steelmakers, who are expected to continue to take up large supplies for a long time to come.

Steel

Although the production of steel in all districts during the month of April was below that of the previous month, the industry continues to be exceptionally active. It must be borne in mind that there were three fewer steel-working days last month than in March. The call for supplies of finished steel is maintained and the structural engineers continue to be heavy consumers. Plates are generally available for fairly early delivery, but the increased activity among shipbuilders is expected to bring about a tighter position in this section. Owing to the heavy pressure for sheets, some delay is being experienced in obtaining supplies and some makers are having to close their order-books for sheets for the time being.

Scrap

With the steelmakers' requirements of scrap still maintained at a very high level, there has been no improvement in the supply position. Despite the very keen competition for scrap, the schedule prices are still in operation. The arrival of imported material is eagerly awaited, but it will no doubt be a long time before sufficient tonnage is received to relieve the acute shortage in this country A noticeable feature of the freight markets of late has been the active chartering of vessels for the conveyance of scrap from the United States to European destinations, including the United Kingdom, Italy, and Sweden

Metals

Confidence in non-ferrous metals continues to be reduced as a result of the international uncertainty, and consumers generally are not buying far ahead.

Copper.—There has been rather a dull tone in this metal during the past week, and buying continues to be for near dates only. Little satisfaction was to be had from the April statistics of the metal, and there has been no easing of the political situation which would have encouraged buyers to cover their future requirements. The present position of the metal was appropriately summed up by the chairman of the French copper-producing company, Mines de Bor, at the meeting of the company in Paris on Thursday last, when he said that the fear of war seemed to have paralysed all initiative.

Metal Exchange quotations were as follow:—

Cash.—Thursday, £40 17s. 6d. to £41; Friday, £41 2s. 6d. to £41 3s. 9d.; Monday, £41 3s. 9d. to £41 6s. 3d.; Tuesday, £41 7s. 6d. to £41 10s.; Wednesday, £41 2s. 6d. to £41 5s.

Three Months.—Thursday, £41 5s. to £41 6s. 3d.; Friday, £41 10s. to £41 11s. 3d.; Monday, £41 10s. to £41 12s. 6d.; Tuesday, £41 15s. to £41 16s. 3d.; Wednesday, £41 10s. to £41 11s. 3d.

Tin.—Under the influence of the control of the buffer pool and the International Tin Committee, this metal is quite firm, despite the fact that the demand is not very impressive. Interest in tin by American consumers is rather quiet, and most buyers are covered well into next month.

Official quotations were as follow:—

Cash.—Thursday, £225 10s. to £225 15s.; Friday, £226 to £226 5s.; Monday, £226 to £226 10s.; Tuesday, £225 5s. to £225 15s.; Wednesday, £226 to £226 5s.

Three Months.—Thursday, £223 to £223 5s.; Friday, £223 10s. to £223 12s. 6d.; Monday, £223 10s. to £223 15s.; Tuesday, £223 10s. to £223 12s. 6d.; Wednesday, £223 15s. to £224.

Spelter.—Featureless conditions prevail in this market and general industrial demand is quiet, with the exception of the galvanisers, who are busy on air-raid shelters.

Daily market prices:—

Ordinary.—Thursday, £13 8s. 9d.; Friday, £13 10s.; Monday, £13 12s. 6d.; Tuesday, £13 13s. 9d.; Wednesday, £13 17s. 6d.

Lead.—The demand has continued to be only moderate, but the outlook is not altogether unsatisfactory. Consumption of lead by the armament industry is naturally quite substantial, but civil consumers are not showing the interest which might be expected at this time of the year. Especially is this the case in the building trade.

Day-to-day quotations:—

Soft Foreign (Prompt).—Thursday, £14 6s. 3d.; Friday, £14 6s. 3d.; Monday, £14 6s. 3d.; Tuesday, £14 6s. 3d.; Wednesday, £14 6s. 3d.

Scrap.—New business continues to be within narrow compass, and the turnover is rather poor. Prices are unchanged.

MACHINERY—*Continued from page 14*

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